REPORT ON THE DANISH OCEANOGRAPHICAL EXPEDITIONS 1908-10
TO THE MEDITERRANEAN AND ADJACENT SEAS
Vol. II. Biology.

A. 7.

Mediterranean Scopelidæ

(Saurus, Aulopus, Chlorophthalmus and Myctophum).

By

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With 49 figures and charts in the text.

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INTRODUCTION.

During the cruises of the Danish research steamer "Thor" in the Atlantic and the Mediterranean in the years 1908—09 and 1910, a very large material of specimens belonging to the *Scopelidæ*, and especially to the genus *Myctophum*, Rafinesque, was collected. The Mediterranean part of the material is dealt with in the present work, including not only the adult forms, but also postlarval and adolescent stages; in nearly all cases indeed, it was found possible to refer the postlarval stages with certainty to their respective species. For purposes of comparison and reference, also, use has been made of the not less extensive material procured by the research schooner "Margrethe" on a cruise from the Færoes to the West Indies in 1913, as also a large amount collected at the instigation of the Royal Danish Committee for the Study of the Sea by Danish merchant vessels in the Mediterranean and the Atlantic. A smaller batch of material also, collected by Capt. G. Hansen on the shore at Messina, March 1911, has likewise been included for treatment here.

I am happy to take this opportunity of expressing my best thanks to Dr. Johs. Schmidt, Head of the Physiological Department of Carlsberg Laboratory, not only for having kindly entrusted the work to my care, but also for the invaluable aid which he has afforded me in carrying out the same, both by advice and practical assistance. I have further to thank Prof. Ad. S. Jensen, of the University at Copenhagen, for courteously granting me permission to go through the material of *Myctophum* used by the late Prof. Chr. Lütken, in the Zoological Museum at Copenhagen, and Prof. E. Vanhöffen, Berlin, for some information concerning the material used by the late Prof. August Brauer and literature difficult of access. I have also to thank mag. sc. P. Jespersen for help in reading the proofs. The calculations in connection with the statistical investigations were made by Frk. E. Fasting.

I. SAURUS, AULOPUS AND CHLOROPHTHALMUS.

SAURUS GRISEUS, Lowe.

Lowe: Trans. Zool. Soc. London. II. 1841.
Cuv. et Val.: Histoire Naturelle. XXII. 1849.
Costa: Fauna del Regno di Napoli. 1836—50.
Günther: Catalogue. Vol. V. 1864.
Steindachner: Sitz.-Ber. K. Akad. Wien. 1868.
Giglioli: Elenco dei Pesci. 1880.
Moreau: Histoire Naturelle. 1881.
Vinciguerra: Ann. Mus. Civ. Stor. Natur. Genova. 1883.
Carus: Faun. Medit. 1889—93.
Goode and Bean: Oceanic Icht. 1895.
Fowler: Proceed. Ac. Nat. Sc. Philadelphia. LXIII. 1911—12.
Sanzo: Atti R. Acc. dei Lincei. XXIV. 1915.

In the material from the eastern Mediterranean, there are three postlarval individuals which must be ascribed to this species, according to SANZO's description of 1915, considered on the one hand together with MAX WEBER's text and figures for *Saurida nebulosa*, Val. and *Synodus synodus*, L. („Die Fische der Siboga-Expedition", 1913, p. 80—83) and on the other hand with TATE REGAN's figure of and text to *Synodus synodus*, L. ("Larval and postlarval fishes", 1916, pl. VII fig. 4).

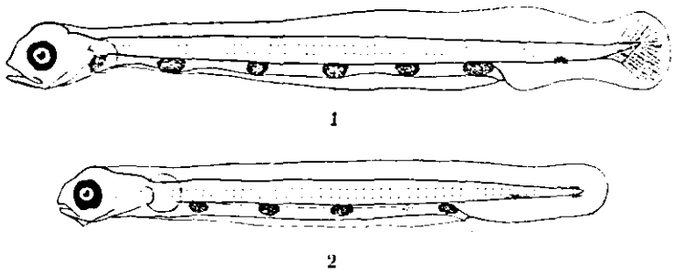

Fig. 1. *Saurus griseus*, Lowe. 1 : 12 mm; 2 : 5 mm.

The specimens were taken with 25—65 m. w., fairly close in to land (see chart under *Chlorophthalmus Agassizi*); the lengths of the specimens were 5, 6.5, and 12 mm (incl. caudal). Otherwise, this species was not taken by the "Thor" in the Mediterranean save at the two stations mentioned below, from which it would seem that the form in question must be of rare occurrence here[1]. In the accompanying sketch, the smallest specimen and the largest one are shown; the latter seems as yet to have no indication either of anal, dorsal or ventral fin. The row of large pigment spots appears to furnish a good systematic character (cf. MAX WEBER l. c. p. 82). For the rest, I refer to SANZO's description (1915).

"Thor". St. 152. $^{27}/_{7}$ 1910. 33°11' N 21°44' E, 10^{50} pm. Y. 200, 25 m. w., 15 min. 1 spec. — 6.5 mm.
— · 183. $^{16}/_{8}$ 1910. 37°52' N 23°09' E, 5^{10} — Y. 200, 65 — , 15 — 2 — — 5 and 12 mm.

AULOPUS FILAMENTOSUS, Cuv.

CUVIER: Le Regne Animal. II. 1817.
BONAPARTE: Iconogr. Fauna Italica. 1832—41.
CUV. et VAL.: Histoire Naturelle. XXII. 1849.
COSTA: Fauna del Regno di Napoli. 1836—50.
GÜNTHER: Catalogue. Vol. V. 1864.
STEINDACHNER: Sitz.-Ber. K. Akad. Wien. 1868.
GIGLIOLI: Elenco dei Pesci. 1880.
MOREAU: Histoire Naturelle. 1881.
VINCIGUERRA: Ann. Mus. Civ. Stor. Natur. Genova. 1885.
CARUS: Faun. Medit. 1889—93.
GOODE and BEAN: Oceanic Icht. 1895.
FOWLER: Proceed. Ac. Nat. Sc. Philadelphia. LXIII. 1911—12.
SANZO: Atti R. Acc. dei Lincei. XXIV. 1915.

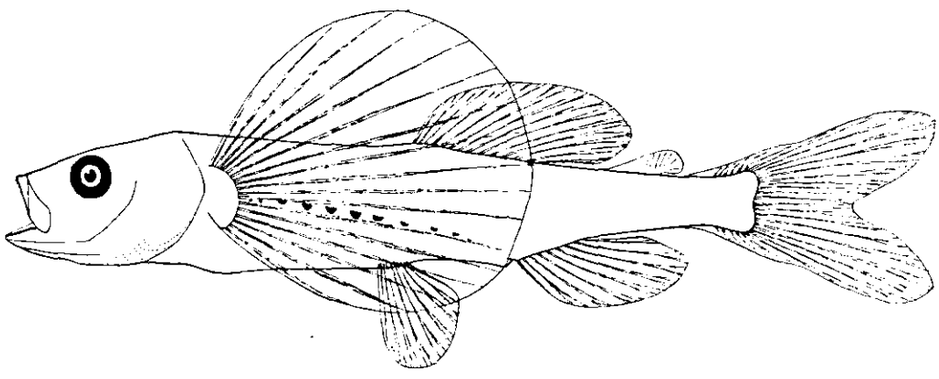

Fig. 2. *Aulopus filamentosus*, Cuv. 28 mm without, 35 mm with caudal.

[1] See further: Appendix p. 149.

Of this species, our present large material of mediterranean postlarvæ contains but a single specimen. The individual in question, measuring 28 mm without, 35 mm with caudal, was taken in the Balearic Sea, at the surface, (see chart for following species). The numbers of fin rays found were as follows: D: 14, A: 9, P: 17, V: 9, and C: x + (10 + 9) + x. For the rest, reference may be made to the figure above, and to SANZO's description of this postlarva (1915).

"Thor". St. 115. 29/6 1910. 38°17'N 1°11'W, 1¹⁰ am. Y. 200, 25 m.w., 15 min. 1 spec. — 28 mm (35 mm incl. c.).

CHLOROPHTHALMUS AGASSIZI, Bp.

Vert.: 47; D: 10—11; A: 7—8; P: 15; V: 8—9; C: x + (10 + 9) + x; Br.: 8; App. pyl.: 8.

BONAPARTE: Iconogr. Fauna Italica. 1832—41.
CUV. et VAL.: Histoire Naturelle. XXII. 1849.
COSTA: Fauna del Regno di Napoli. 1836—50.
GÜNTHER: Catalogue. Vol. V. 1864.
GIGLIOLI: Elenco dei Pesci. 1880.
VINCIGUERRA: Ann. Mus. Civ. Stor. Natur. Genova. 1885.
CARUS: Faun. Medit. 1889—93.
GOODE and BEAN: Oceanic Icht. 1895.
FOWLER: Proceed. Ac. Nat. Sc. Philadelphia. LXIII. 1911—12.
SANZO: Atti R. Acc. dei Lincei. XXIV. 1915.

Of this species, we have in all 63 specimens from the Mediterranean, by far the greater number of these being postlarval stages, and only two larger specimens (44 and 46 mm excl. c.). The two large ones were picked up on the shore near Messina by Capt. G. HANSEN, in March 1911; the "Thor" found altogether 48, and the "Pangan" 13 postlarvæ (see also table of hauls below).

The postlarvæ were described by SANZO in 1915. The sketches Fig. 3 given show the development of these postlarvæ from a length of 6.5 mm to 25 mm and also the melanophores characteristic of the postlarval stages: the large caudal melanophore and the internal pigment below the pectoral fin (peritoneal). It will also be seen that the smallest postlarvæ have infra- and supracaudally a small melanophore, which disappears, however, in the somewhat older stages, though it may, as shown in Fig. 3, at times be found in specimens up to 10 mm or thereabouts.

In the two large specimens, there are no remains of these melanophores, but the investigation shows that the postlarvæ do belong to just this species. The agreement is

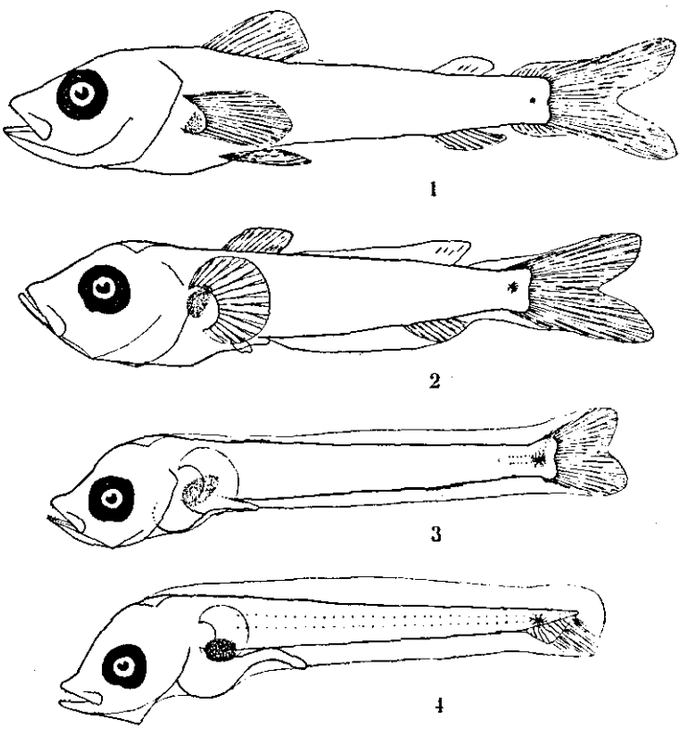

Fig. 3. *Chlorophthalmus Agassizi*, Bp. 1: 25 mm without, 31.5 mm with caudal; 2: 13 mm, 16 mm; 3: 9.5 mm; 11 mm; 4: 6.5 mm.

evident first of all in the number of fin rays, position of the anus[1]), and of the fins, in addition to which, the number of vertebræ was likewise found to agree. One of the two large specimens had 47 (17 + 30) vertebræ[2]) and the postlarvæ were found to have 46—48.

The accompanying sketch shows one of the large specimens viewed laterally, from below, and from above, to show the position of the eye in this species. None of the postlarvæ have the eye thus placed. There is possibly a very slight turning discernible in the largest postlarvæ, of 25 mm; the movement of the eye must thus take place in stages between 25 and 44 mm. The largest postlarvæ (25 mm) was taken with 1000 m. w. and it is thus reasonable to suppose that the alteration in the position of the eye does not take place until the fish have changed their level in the water from the surface layers down to the greater depths. The figure further shows the chequered pigmentation in this stage.

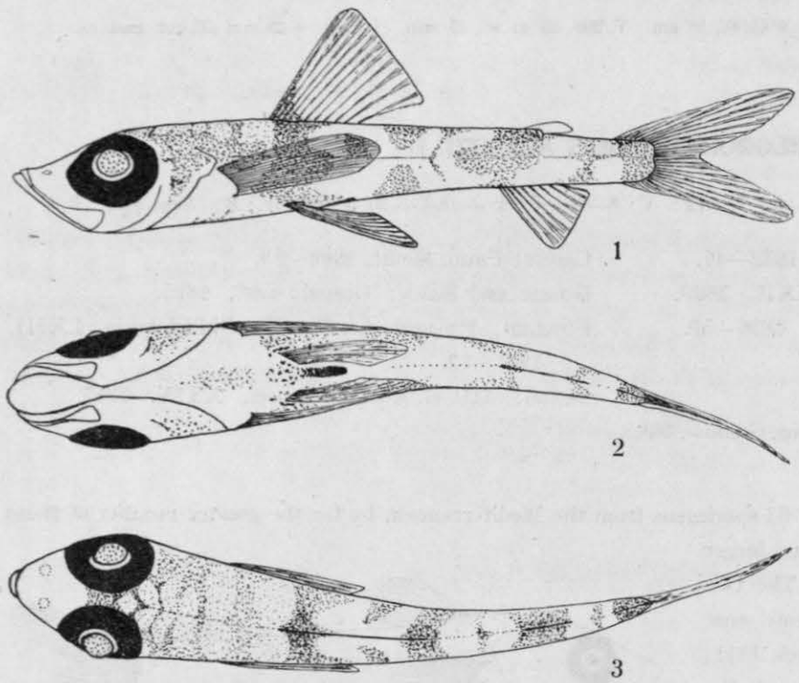

Fig. 4. *Chlorophthalmus Agassizi*, Bp., lateral, ventral and dorsal view. 46 mm without caudal. Messina, March 1911, Capt. G. Hansen.

Chlorophthalmus Agassizi is known from the Mediterranean and the Atlantic. In the present mediterranean material, we have, as mentioned, besides the two large specimens found near the Strait of Messina, only postlarval stages. The accompanying chart shows the distribution in the Mediterranean. In this connection it should be added, that the very great majority of postlarvæ were taken in the eastern basin, viz. 52 out of 61.

The numbers for the various areas are as follows:

Area	Catalonian Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Levantine Sea	Ægean Sea
No. of postlarvæ..	6	1	2	11	28	13

The species was not found either in the Alboran Sea or in the Adriatic, and appears to prefer the warmer water of the eastern basin.

The specimens taken were nearly all from stations over great depths, more than 1000 metres; only one or two were taken closer in to land.

With regard to vertical distribution of the postlarvæ in this species, we find that by far the majority are taken in the upper water layers (chiefly with 25—65 m. w.) as will be seen from the table on p. 7.

[1]) Tate Regan considers this, in connection with other structural (osteological) features, as indicating that this genus is closely allied to *Paralepis*. Ann. Mag. Nat. Hist. (8) VII. 1911, p. 120—133. "Larval and postlarval fishes". British Antarctic Exped., 1910. 1916, p. 150.

[2]) The urostyle consists of two segments, here counted as one (cf. *Myctophum Rissoi* p. 29).

The specimens from the "Pangan", which are not included in the above table, were likewise taken in the surface layers (with 28—108 m. w.). The hauls at St. 160 (see table p. 8) in particular serve well to illustrate the vertical distribution of the postlarvæ.

Length of wire in metres	No. of spec.	No. of hauls
25	35	7
65	2	2
300	5	1
1000	4	2
4000	2	1

There can hardly be any doubt that the species is, in the adult stages, a fairly deep-living form, (cf. MAX WEBER: „Die Fische der Siboga-Expedition", 1913 p. 79). The two largest specimens in the material here were found in the Strait of Messina, and may thus have come from greater depths; in the post-larval material, the largest specimen, of 25 mm, was taken with 1000 m. w. and was perhaps actually caught at a depth of abt. 500 metres. We cannot, however, from the present material, state anything definite with regard to the size at which the post-larvæ move down from the upper water layers to deeper levels, or at what depth they live in the adult stages.

The species is, as mentioned, evidently a warm-water form which does not spawn until some way on in summer, and then chiefly in the warmest part of the Mediterranean, the eastern basin. The greater part of the material was taken in August, i. e. at the time when the temperature of the surface water is at its maximum.

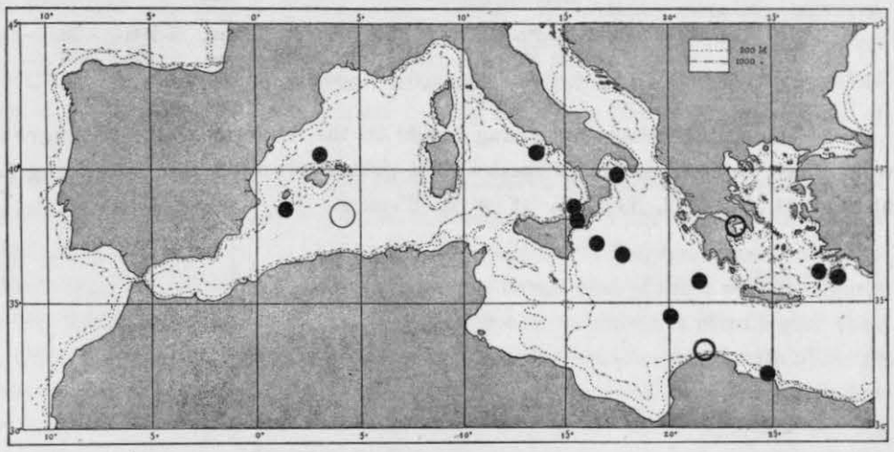

Fig. 5. Distribution of *Chlorophthalmus Agassizi*, Bp., ●, *Saurus griseus*, Lowe, ○, and *Aulopus filamentosus*, Cuv., ○, according to the investigations of the "Thor".

In the following table, showing lengths of specimens in the different months, it will be noticed that the smallest ones were taken more especially in August, the large ones not making their appearance until December[1]). It would then seem not unlikely that the specimens taken at Messina in March were abt. $^2/_3$ year old. This point, however, as also the question of when the species attains maturity, needs further investigation.

Size in mm	March 1911	July 1910	Aug. 1910—11	Sept. 1910, 1913	Decbr. 1908	Size in mm	March 1911	July 1910	Aug. 1910—11	Sept. 1910, 1913	Decbr. 1908
46	1					18					
45						17	..	..	1	1	
44	1					16	..	..	..	..	1
—						15	..	..	..	..	1
—						14					
—						13	..	..	1		
25	..	..	..	..	1	12	..	..	2		
24						11	..	..	6		
23						10	..	..	6		
22						9	..	1	8		
21	..	..	..	..	1	8	..	..	12	1	
20						7	..	..	11		
19						6.5	..	..	7		

[1]) MAZZARELLI states (in "Gli animali abissali e le correnti sottomarini dello Stretto di Messina", 1909) that the species is found at Messina during the months of October—February.

List of stations where specimens of *Chlorophthalmus Agassizi* Bp, were taken.

"Thor"	St. 10,	$^{15}/_{12}$	1908,	37°21′ N	16°45′ E,	5^{00} am,	Y. 200,	25 m. w.,	60 min.	1	spec.
—	- —	—	—	—	—	6^{10} am,	—	65 — ,	60 — .	1	—
—	- 11,	$^{16}/_{12}$	1908,	36°57′ N	18°16′ E,	5^{25} am,	—	65 — ,	60 — .	1	—
—	- 13,	$^{19}/_{12}$	1908,	39°43′ N	17°30′ E,	7^{05} pm,	—	1000 — ,	60 — .	1	—
—	- 154,	$^{29}/_{7}$	1910,	32°10′ N	24°46′ E,	3^{30} am,	—	25 — ,	30 — .	1	—
—	- 160,	$^{1}/_{8}$	1910,	35°59′ N	28°14′ E,	2^{00} am,	—	25 — ,	30 — .	17	—
—	- —	—	—	—	—	2^{45} am,	—	300 — ,	30 — .	5	—
—	- —	—	—	—	—	3^{35} am,	—	1000 — ,	60 — .	3	—
—	- —	—	—	—	—	3^{30} pm,	C. 200,	4000 — ,	60 — .	2	—
—	- 161,	$^{2}/_{8}$	1910,	36°12′ N	27°16′ E,	3^{00} am,	Y. 200,	25 — ,	30 — .	13	—
—	- 194,	$^{27}/_{8}$	1910,	38°33′ N	15°29′ E,	5^{00} am,	—	25 — ,	15 — .	1	—
—	- 197,	$^{24}/_{8}$	1910,	40°34′ N	13°36′ E,	7^{45} pm,	—	25 — ,	15 — .	1	—
—	- 216,	$^{1}/_{9}$	1910,	38°31′ N	1°24′ E,	5^{10} am,	—	25 — ,	30 — .	1	—
S S "Pangan"	- 339,	$^{20}/_{8}$	1911,	40°30′ N	3°10′ E,	3^{00} am,	S. 200,	28 — ,	30 — .	6	—
—	- 340,	$^{26}/_{8}$	1911,	35°50′ N	21°30′ E,	9^{00} pm,	S. 150,	108 — ,	30 — .	6	—
—	- 743,	$^{23}/_{9}$	1913,	34°26′ N	20°08′ E,	10^{00} pm,	—	95 — ,	30 — .	1	—

Among the pelagic fish-young caught in the Atlantic by the "Margrethe" I have found a specimen which must be ascribed to this species. The individual in question, measuring 12 mm (excl. caudal), was taken at St. 1014, $^{26}/_{8}$ 1913, 33′06′ N, 31°08′ W, 65 m. w.

II. MYCTOPHUM.

A. Introduction to the genus Myctophum.

1. Literature, Nomenclature, etc.

In the systematic arrangement, I have especially had recourse to A. Brauer: „Die Tiefsee-Fische" (1906—08), this modern work comprising in itself the greater part of what has been done by previous writers. In addition, the pioneer work by Lütken: "Scopelini Musei Zoologici Universitatis Hauniensis" (1892) has in many respects been of great use, and Holt and Byrne's excellent little work: "Fishes of the genus Scopelus" (1911) has afforded me valuable aid in treatment of the material. Goode and Bean's "Oceanic Ichthyology" (1895) on the other hand, I have only employed to a slight degree, as I am entirely in agreement with the statements of Brauer and Holt & Byrne with regard to the utility of that work for systematic treatment of the *Scopelids*. In dealing with this little-varying genus, it is absolutely imperative to apply a very definite terminology, and the standard works by Lütken and Brauer must here serve as a guide. It is therefore to be regretted that American ichthyologists, even in the most recent works, still take Goode and Bean as a model.

In the present work, I have entirely followed Brauer's terminology, as given in "Die Tiefsee-Fische" 1906, p. 153—161. The abbreviations employed will be found noted below, at the commencement of the Key to the Mediterranean species. In all essentials, also, I have followed Brauer's system of division and nomenclature; in the case of some few species, however, there will at one or two places in the text be found some slight corrections with regard to synonymy, etc. but all of only minor significance. For literature published prior to the appearance of "Die Tiefsee-Fische", the reader may refer to Brauer.

A few words may here be said as to other expressions etc. employed in the present work. In treatment of the material I have distinguished between the postlarval and the adult stages; by adult stages I understand all such as have passed through the metamorphosis stage, and have thus acquired all or nearly all the characters

which distinguish the oldest individuals; they must thus be taken in contrast to the partly unpigmented postlarval stages without photophores, or with these only indicated. As will be shown in the following, there is not only in structure etc., but also in biological respects, a great difference between these two stages; between them lies the evidently brief metamorphosis stage, during which, as we know, various morphological changes take place. (In the lists and surveys given in the present work, this stage is included among the postlarval stages). During metamorphosis especially, the formation of the photophores begins, the pectoral fins take on something of their later appearance, the adult pigment commences to develop, etc. A certain reduction in length, also, during metamorphosis, seems to occur in all species. In the Teleosteans, the passing over from the postlarval form of existence generally involves, as we know, a reduction in the relative size of the eye; in *Scopelids*, on the other hand, an increase in the relative size of this organ is the general rule (certain species, however, are exceptions), and this increase especially takes place from the metamorphosis stage onwards. It is not my intention, however, in the present work, to go further into the highly interesting changes of form which take place in the postlarval stages of this genus. In the postlarvæ there is, especially within the *Myctophum* group itself, and far less marked in the remaining groups, a dorsal sinus; this "floater" is mentioned by HOLT (1898) p. 554—556 in postlarvæ of *Myctophum glaciale*.

In the present work, I have throughout noted all length measurements of fish without the caudal fin, as the material, which is preserved in formol, often has fins etc. somewhat damaged. Where the length of the caudal is included in the total length, this is expressly stated. The figures given for number of fin rays, number of vertebræ, etc. are all from countings made by myself. The records in extant works do not always agree with the figures I have found; this is largely due to the fact that the number of rays in Atlantic specimens is often higher than in fish from the Mediterranean. The counts were in nearly all cases made from individuals stained with alizarine and clarified in xylol, which gives a higher degree of accuracy than where this is not done. As a rule there was a sufficient quantity of material available for this purpose. In the records here given, all the figures found are noted, and the value or values most frequently occurring emphasised. In the case of the anal and dorsal, the last ray is double; in the countings, this has been reckoned as one. The ventral has always 8 rays, but may at times have a small point at the bottom, like a ninth ray. As regards the countings of vertebræ, reference may be made to the section devoted thereto in the following.

The number of maculæ anales is in this genus, as we know, a character of very great systematic importance, and I have therefore as far as possible in all species determined the number of these photophores in nearly all the specimens dealt with. I have preferred to work throughout with the photophores of the left side, but have in a great number of species also included the photophores of the right side, as it has been found that there is very often a difference between the numbers on the two sides of the fish. Such countings on a large scale have hitherto only been made by BRAUER. In dealing with *Myctophum glaciale*, for instance, I have utilised, *inter alia*, the number of maculæ anales to bring out by variational statistics the difference between an Atlantic and a Mediterranean race. In so doing, it is necessary to note the total number of maculæ anales anteriores et posteriores, but it is interesting to note with what frequency the combinations of the two groups occur. By way of example may be mentioned, that in *Myctophum glaciale*, the number of 12 maculæ anales covers the combinations $7 + 5$, $6 + 6$ and $5 + 7$, the three combinations appearing with a greatly varying degree of frequency. I have used a particular method of dealing with this feature, which I have carried out for all species to the greatest possible extent, as in a so extensive and little-varying group as this, we can never have too many data on which to base conclusions as to whether an individual belongs to this or that species or race. The importance of such countings may perhaps be best illustrated by mentioning that it was COLLET's and GRIEG's few records of maculæ anales in *Myctophum glaciale* from the Atlantic (1903 and 1911) which led me to a further examination of this character and its possible utility for the purpose of distinction between the two above-mentioned races of this species. In the present work, the following variational-statistic formulæ are employed:

$$\sigma = \pm\sqrt{\frac{\Sigma Mp^2}{n+1} + b^2};\quad Fl. = \pm\frac{\sigma}{\sqrt{n}} \cdot 0.67449 \times 5,$$

where n = total number of specimens, M = the mean of all counts, σ = standard deviation, $Fl.$ = fluctuation of average.

With regard to the terms employed in the work for the various areas of the Mediterranean, position of stations, etc. it will suffice here to refer to the Introduction by Dr. JOHS. SCHMIDT to these investigations[1]). The expressions "positive station" or "positive haul" indicate respectively stations where any specimens of the species concerned were taken, or hauls in which such species was at all represented. Frequently also, mention is made of the number of individuals per positive hour; the meaning here will easily be understood from the foregoing. The term "day haul" is used here, as in P. JESPERSEN's paper in this Report[2]) to denote hauls made between the hours of 6 a. m. and 6 p. m., and "night hauls" will correspondingly be those made between 6 p. m. and 6 a. m. (There is a source of error here, of course; the length of the "day" down in the water will naturally not be the same during different seasons, nor at different places during the same).

2. Material, and general survey.

I have in the present investigations only included material derived from the Mediterranean itself and the Sea of Marmora, comprising some 22.000 specimens; now and again, however, where a point of particular interest arose, I have referred to the material from the Atlantic. In the case of certain species, it would have been natural to include collections procured from Atlantic waters immediately adjacent to the Mediterranean, since, as we know, certain water-layers in these areas belong hydrographically to the Mediterranean. I have not, however, included these, as the threshold at Gibraltar forms an absolute limit for a great number of Atlantic species, and I hope in a subsequent work to return to the great Atlantic material separately. All the *Myctophum* species found in the Mediterranean occur also in the Atlantic. The following species have been taken in the Mediterranean: *Myctophum Rissoi, M. glaciale, M. Benoiti, M. Hygomi, M. punctatum, M. Humboldti, M. Coccoi, Diaphus Gemellarii, D. Dofleini, D. Rafinesquei, D. Holti,* sp. n., *Lampanyctus maderensis, L. elongatus, L. alatus* and *L. crocodilus.* In addition to these, *Diaphus metopoclampus* is mentioned from the Mediterranean (for this species *vide infra*). ZUGMAYER (1911) further records *Myctophum affine, Myctophum Andreæ* and *Lampanyctus gemmifer,* a single specimen of each, from the western Mediterranean. LO BIANCO (1903—04) states that two small specimens of *Myctophum affine* were taken in the western Mediterranean. As these species are found in the North Atlantic, there would be nothing particularly surprising in their being met with in the western Mediterranean. The "Thor" however, found none of these species here, either in adult nor postlarval stages[3]). In the Bay of Cadiz, all the above-mentioned fifteen species were taken, either in both adult and postlarval stages, or in one of the two. In addition, the following species were also taken here, as far as the Straits of Gibraltar: *Myctophum laternatum* (with identified postlarvæ), *M. Valdiviæ, M. rarum, M, rarum forma integer, Lampanyctus longipes, L. nigrum* and *L. gemmifer,* as also 3—4 other species, evidently not hitherto described, belonging to the *Myctophum-* and *Lampanyctus*-groups. It will here be well to call to mind that P. JESPERSEN, in his work on *Argyropelecus* and *Sternoptyx,* has shown that *Argyropelecus olfersi, A. affinis* and *Sternoptyx diaphana* likewise halt at the Straits of Gibraltar, and do not penetrate into the Mediterranean. And it may also here be pointed out that no postlarval stages of the above-mentioned Atlantic species from the Bay of Cadiz were taken in the Mediterranean itself. The hydrographical conditions in the Straits of Gibraltar will be partly apparent from the section given below.

[1] "Report on the Danish Oceanographical Expeditions 1908—1910 to the Mediterranean and adjacent seas. Vol. I. Copenhagen 1912".

[2] P. JESPERSEN: *Sternoptychidæ (Argyropelecus* and *Sternoptyx).* Vol. II. A. 2. Copenhagen 1915.

[3] As STEINDACHNER's species *Scopelus Heideri* doubtless is *Myctophum punctatum,* so also MOREAU's species *Scopelus Veranyi* is evidently identical with *Myctophum Humboldti;* it is therefore not noted here as a separate species.

The whole material is distributed among the different species as follows:

Myctophum Rissoi	20	adults	+	105	postlarvæ
— *glaciale*	1333	—	+	3672	—
— *Benoiti*	583	—	+	4160	—
— *Hygomi*	65	—	+		
— *punctatum*	176	—	+	1256	—
— *Humboldti*	49	—	+	210	—
— *Coccoi*	27	—	+	37	—
Diaphus Gemellarii	1	—	+	77	—
— *Dofleini*	718	—	+	691	—
— *Rafinesquei*	95	—	+	28	—
— *Holti*, sp. n.	161	—	+	477	—
Lampanyctus maderensis	1097	—	+	1330	—
— *elongatus*	31	—	+	620	—
— *alatus*	313	—	+	202	—
— *crocodilus*	59	—	+	1087	—

We have thus in all 21,679 *Scopelids*, of which 16.951 are postlarval stages, and 4.728 adults. Of the postlarval stages, the smallest are abt. 4.5 to 5 mm long; stages below this length were not found, probably owing to the destructive effect of the implements used. The above survey of the quantities in which the various species

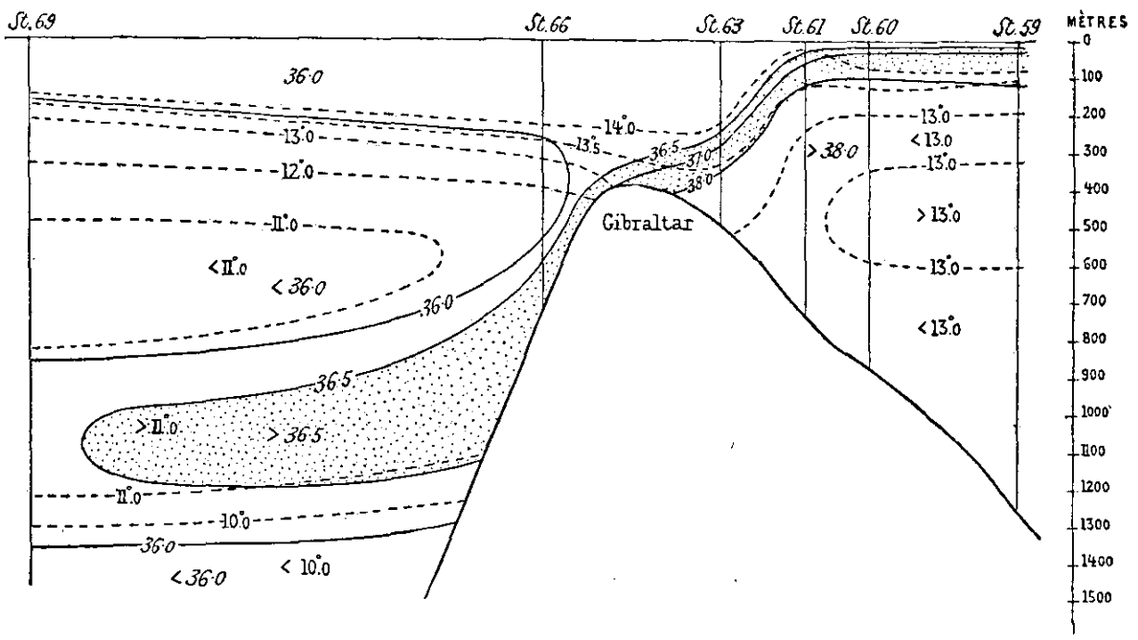

Fig. 6. Hydrographical section through the Straits of Gibraltar (from SCHMIDT, NIELSEN and JACOBSEN, 1910).

were taken will give an idea as to their relative frequency in the Mediterranean; we should not, however, attach too great importance to the figures, as several circumstances may have to be taken into consideration, such as the season, weather, locality, etc. With regard to the distribution of the different species, amount of catch in winter and summer etc. reference may be made to the special section. A few preliminary remarks will here suffice.

The "Thor" worked in the Mediterranean more particularly over deep water, and most of the Mediterranean was covered; not, however, the northern part of the Adriatic nor the extreme eastern part of the Mediter-

ranean, nor the shallow water off the coast of Tunis, etc. North of the deep southern part of the Adriatic, species of this genus will probably only occasionally be found. Altogether, it seems possible that the expedition may be able to solve a number of questions concerning the distribution of *Scopelids*, frequency of occurrence, etc. in the Mediterranean, as no previous expedition has procured so large a material of this genus. The reason of this must doubtless lie very largely in the fact that the expedition was mainly directed towards the collection of pelagic material, for which purpose a very suitable implement was used, viz. Dr. PETERSEN's young-fish trawl.

During the winter cruise from 1908—09, the young-fish trawl or the ring-trawl was called into play at 41 stations in the Mediterranean, and despite unfavourable weather, *Scopelids* were taken at all these stations save one. Of adult and postlarval stages, about 50 specimens in all per hour were taken. On the summer cruise in 1910, the young-fish trawl or the ring-trawl was used at 90 stations, and *Scopelids* were taken at all save seven, most of which were in so shallow water that the finding of *Scopelids* was hardly to be expected at all. Of adult and postlarval stages, in all, some 150 specimens were taken per hour.

In water of lesser depth (inside the 500—1000 metre limits) most of the *Scopelids* taken were postlarvæ; the principal reason why these were found in here must be sought in the peculiar current conditions prevailing in the Mediterranean. The main features of these currents will be seen from the accompanying chart.

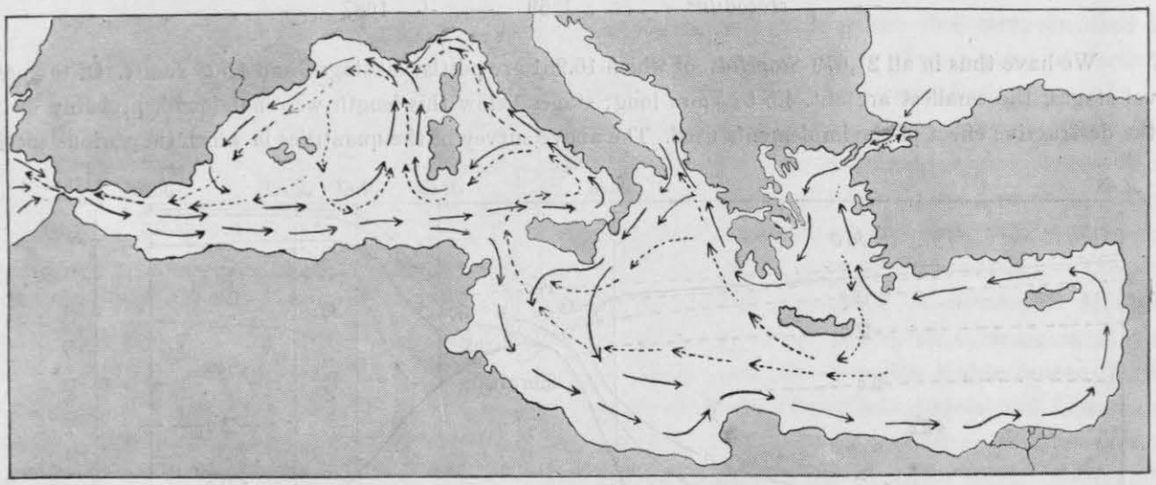

Fig. 7. The Currents of the Mediterranean (from J. N. NIELSEN, 1912). ⟶ Surface water, ⇢ intermediate water.

While the material dealt with has in certain respects given excellent results, I must nevertheless point out that the highly complicated hydrographical conditions in the Mediterranean render it very difficult to lay down any general rules for the horizontal and vertical distribution etc.; Atlantic material would doubtless, when similarly treated, give a far clearer view.

We can however, on the basis of the present material, yet learn much of biological interest. We may point out, for instance, that the horizontal distribution differs somewhat between the different species, but the great majority of the *Scopelids* were taken in the Alboran Sea and the immediately adjacent waters of the Balearic Sea, as will be seen from the chart below. One or two species also, appear to be particularly numerous in the Ægean and the Sea of Marmora. Details as to distribution of the different species will be found in the special section.

Similar reference to the separate section must also be made with regard to vertical distribution of the various species. I will merely mention here, that the majority of species appear to be found in the upper 150 metres or so (300 at the outside); this applies at any rate to the youngest and oldest stages, and at night — (according to LO BIANCO's division of the Mediterranean plankton, in the case of postlarvæ, belonging to the phaoplankton

and the upper knephoplankton). In dealing with the vertical distribution, we are led to the discussion of two highly complicated questions; the ontogenetic vertical migrations, and the vertical day-to-night migrations. With regard to the former point, we must here refer to the subsequent section on the typical meta-

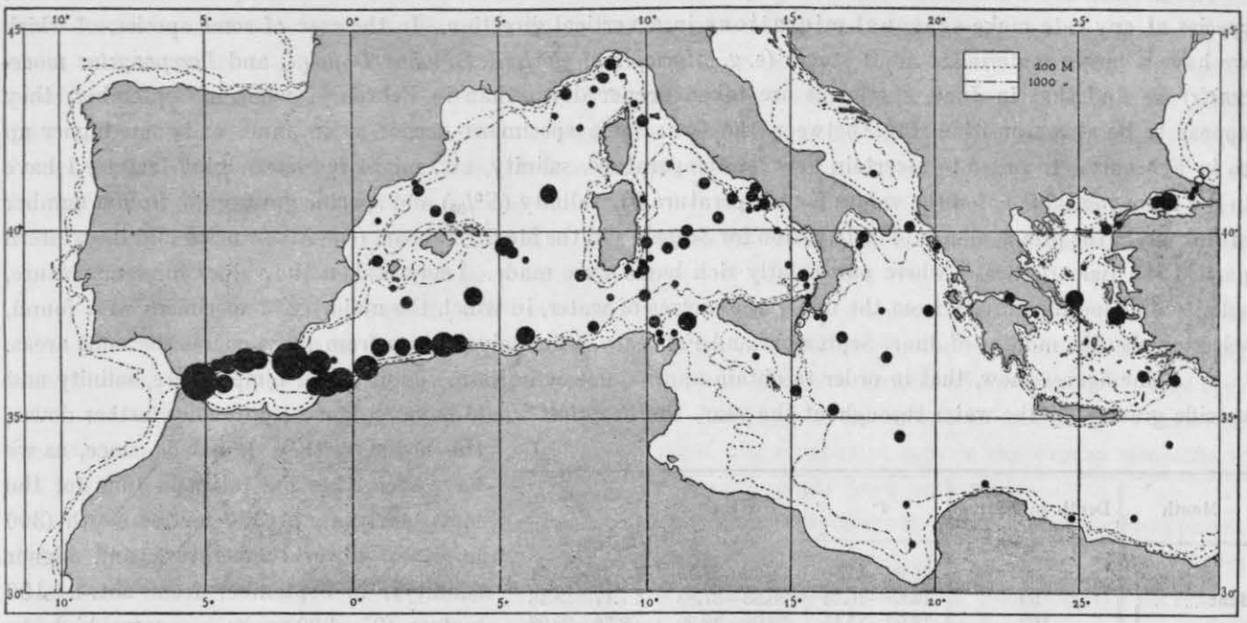

Fig. 8. Distribution of *Scopelids* in the Mediterranean (adult and postlarval specimens) taken with young-fish-trawl or ring-trawl by the "Thor" in 1908—1910.
o 0 specimens. • < 50 spec. ● 50—250 spec. ● 250—500 spec. ● ● > 500 spec.

morphosis stages (from which it will be seen that certainly the majority of the *Scopelids* must for some part of their life be classed among the scotoplankton [Lo Bianco]). As regards the latter question, we must say that the material does not really tell us anything definite.

The day hauls were not nearly so numerous as the night, as will be seen from the following table.

Day hauls in the upper water layers (abt. 150 metres, fished through with 300—400 metres of wire) yielded only very few adult *Scopelids*; there were, however, *inter alia*, some few large specimens. At greater depths, only a few were taken, and most of these were found to be stages which during their ontogenetic migration naturally belong there. If certain species, in the course of their day-and-night movements, sink down to depths where the light only penetrates poorly, or not at all, it might be expected that it should be possible to take here during the day if not as many, at any rate something like the number taken during the night in the upper 150 metres. This, however, is by no means the case; on the whole, not more are taken here by day than during the night. In dealing with these rapidly-moving little fish, we must doubtless bear in mind, as an essential point, that they are able to avoid the nets by day. It seems probable that the *Scopelids*, which most likely are twilight fishes, do not make day-and-night migrations of any

Table showing all hauls made in the Mediterranean.

Length of wire	Day hauls	Night hauls	Total	Percentage of day hauls
25 meters....	7	75	82	8.5 %
65 —	12	41	53	22.6 %
150— 250 —	3	6	9	33.3 %
300— 400 —	23	51	74	31.0 %
500— 800 —	5	13	18	27.7 %
1000—1200 —	11	20	31	35.4 %
1400—1800 —	2	5	7	28.5 %
>2000 —	7	6	13	53.8 %
Total...	70	217	287	24.3 %

very great extent; for it would surely be too much to suppose that they should move down by day to depths of over 1000—2000 metres, where the expedition fished but little (eight hours in all with over 2000 m. w., yielding 23 adult specimens in 6 hauls — these possibly taken while hauling in).

Attention should also be drawn to a peculiar feature in the vertical distribution, which shows that some species at any rate make seasonal migrations in a vertical direction. In the case of some species, of which we have a larger material of adult stages (e. g. *Myctophum glaciale*, *Diaphus Dofleini*, and *Lampanyctus maderensis*) we find that in June, specimens are taken deeper down than in February, while in September, they appear to be at a transition stage between the two: some specimens deeper as in June, and some higher up as in February. In order to ascertain how far temperature, salinity, etc. might be determining factors, I have in the following table noted the values for temperature (t), salinity ($S‰$) and specific gravity (σ_t) from a number of stations in the principal area of distribution for *Scopelids* in the Mediterranean, (the Alboran Sea and the western part of the Balearic Sea)[1]) where particularly rich hauls were made. I have taken the values for temperature, salinity and specific gravity from the upper 150 metres of water, in which the majority of specimens were found, selecting also the months of June, September and February, which give values from more or less the same areas.

The figures show, that in order to obtain approximately uniform conditions of temperature, salinity and specific gravity in the water throughout the year, the *Scopelids* would have to move continually farther down; this however, they do not do, since, as we have seen, they are taken in June for the most part in abt. 150 metres depth (300 m. w. — lower temperature and higher salinity); in September from abt. 0—150 metres (25—300 m. w. — very high to lower temperature, and lower to higher salinity); and in February from abt. 0—50 metres (25—65 m. w. — lower temperature and lower salinity). Here then, it would seem that there must be another determining factor; possibly the intensity of light in June-September-February[2]).

Month	Depth in metres	$t°$	$S‰$	σ_t
June	0	16.80—21.96	36.26—37.19	25.68—26.54
	50	13.65—16.04	36.53—37.83	27.17—28.46
	150	12.92—13.15	38.08—38.30	28.76—28.98
September	0	18.42—23.70	36.45—36.74	25.00—26.30
	50	15.02—16.78	36.44—36.78	26.69—27.36
	150	13.05—14.62	36.73—38.19	27.41—28.87
February	0	13.40—14.50	36.44—37.39	27.21—28.18
	50	14.02—14.50	36.71—37.83	27.44—28.39
	150	12.97—14.10	37.38—38.17	28.02—28.87

With regard to propagation, the following general features may here be noted.

Lo Bianco (1910—13) states (p. 146) that various species of *Scopelids* spawn all the year round. This is correct as regards certain species (which nevertheless, as a rule, exhibit a distinct maximum in spawning time), as will also be seen from the special section in these pages, but it does not apply to all species. *Lampanyctus maderensis*, for instance, is a typical example of a species having a narrowly restricted spawning time. How far this may stand in relation to the horizontal and vertical distribution of the species in the Atlantic it is impossible to say with certainty at the present, the treatment of the Atlantic material being not yet completed; the point is, however, evidently one which it would be well to bear in mind in future biological investigations.

The material further shows — e. g. for the species just mentioned, and others, — that each fish hardly spawns more than once in the year.

It is found, again, that several species of *Scopelids* live in large shoals; the impression is amply confirmed by considering the results of the separate hauls. It will as a rule be seen that hauls yielding say a hundred or a couple of hundred adult specimens, are composed almost entirely of fish from the same group (Group 0 or Group I). It is by no means all species, however, which appear to live thus socially; with several of the less numerously

[1] The same applies, by the way, also to other parts of the Mediterranean.

[2] See: C. Chun: Die pelagische Tierwelt in gröszeren Meerestiefen. Bibl. Zoologica. Cassel 1887—88.
H. Lohmann: Neue Untersuchungen über den Reichthum des Meeres an Plankton. Wissenschaftliche Meeresuntersuchungen. Bd. VII. Kiel 1903.

represented species, in any case for Group I and older groups, we find only a single one, or some few specimens in each haul, and this seems to apply more particularly to the deeper-living species.

As to whether the species seek other water-layers when about to spawn, nothing definite can be said. The fact that postlarvæ of *Myctophum Rissoi*, for instance, are mainly taken in about the same water layers in which the adults must be supposed to live, does not appear suggestive of vertical spawning migrations. Against this, again, we have the facts as noted for other species (partly, for instance, what we find in the case of *Lampanyctus crocodilus*). Possibly however, the matter may be as suggested by HJORT (1912) viz. that the eggs after being spawned rise from one water layer to another. In any case, it is obviously impossible to enter upon an investigation of this point before we have arrived at a definite conclusion with regard to such a question as the extent of the day-and-night movements already referred to. All we can say here is, that the great majority of the postlarval stages belong to the very uppermost water layers, but are, like the adults, also found at somewhat different depths during different times of the year.

The various species of *Scopelids* differ considerably as regards the number of eggs found in the ovaries of the fish. The value seems to depend in some degree upon the size attained by the individual before reaching maturity. In the special section of the present work will be found some few records of the number of large eggs in the ovaries[1]). The figure varies from abt. 200 to close on 4000 eggs in the specimens examined. Within the separate groups, again, *Myctophum*, *Diaphus* and *Lampanyctus*, the number of eggs in the ovaries also differs; this is clearly seen by going through the list of species for which counts have been made.

Among *Scopelids*, we can distinguish between smaller and larger species; the difference is partly apparent already in the postlarval stages in the size which these attain prior to metamorphosis. The former group includes for instance *Myctophum glaciale*, *Diaphus Dofleini* and *Lampanyctus alatus*; the latter comprises typical species such as *Myctophum Humboldti* and *Lampanyctus crocodilus*. Some few, again, appear to take an intermediate place between the two groups, as for instance *Myctophum Hygomi*.

The yield of large specimens obtained with the fishing implements ordinarily employed is unfortunately so small that we cannot at present discuss at any length the question as to the age which these fish generally attain. My own impression is that the various species differ not a little in this respect. It would seem reasonable to suppose, for instance, that a species such as *Myctophum glaciale* in the Mediterranean generally dies after spawning, abt. 1—2 years old, as it would be remarkable that the present large material should contain not a single large specimen of the older year-classes in so common a species if such are to be found in the Mediterranean at all. Of other species, such as *Myctophum Humboldti* and *Lampanyctus crocodilus*, we have specimens right up to 100 mm. It is beyond question, however, that other species in the Mediterranean can attain an age of several years; it will here suffice to mention *Lampanyctus crocodilus*, of which specimens up to 200 mm are known.

The food of the *Scopelids* consists essentially of Crustaceans, *Copepods*, etc.; remains of these are often found in considerable quantities in the stomach. We may, however, also find remains of postlarvæ of fishes; thus I have seen specimens of *Lampanyctus maderensis* having in the stomach postlarval stages of the same species.

It is in many cases quite common to find *parasitic Copepods* on several of the species.

3. The postlarval stages.

As already mentioned, the material consists for the greater part of postlarval stages. Despite keeping in formalin for several years, the melanophores in any case appear to be more or less well preserved (of the remaining chromatophores, xanthophores etc., there is of course now nothing to be seen). Some samples, however, have suffered more than others, and it is likely that a study of newly caught or more recently preserved postlarvæ may render it possible to determine the characters apparent in the melanophores with a higher degree of

[1] The ovaries were always stained prior to counting; by so doing, a uniform intensity of colour is imparted to all the large eggs, which appear in marked contrast to the smaller ones. For this purpose, of course, only those specimens can be used which appear to be near maturity.

accuracy than I have here been able to attain. It was soon found that the position of the melanophores in these postlarval stages, as in those of so many other fish, afforded almost the only means of identifying the species, at any rate, as regards the smallest forms, where fin rays and vertebræ were not yet distinctly indicated. The obvious treatment, then, was by the serial method, as pointed out by JOHS. SCHMIDT in "The Pelagic postlarval stages of the Atlantic species of Gadus"[1]) p. 1—7. And to this work I can generally refer, as regards method of procedure and nomenclature.

There are in extant literature some descriptions of postlarvæ of *Scopelids*, but in most cases it has been found that the postlarval stages described have not been referred to the proper species. The only characters which the writers as a rule have employed, are the number of rays in anal and dorsal, number of myotomes, and outer appearance. With regard to the first-mentioned character, I will admit that this is of importance, but only in connection with others, or with the serial method. The second character is, as far as my experience goes, too uncertain and difficult of application to be of any utility in dealing with the postlarvæ of this genus. And as for the last, the resemblance to the adult form, it is impossible to use this at all, as the development of the postlarvæ in *Scopelids* from the larval stages to the attainment of permanent adult appearance is subject to an extremely thorough alteration of form. By way of example we may note the change which takes place in the two *Lampanyctus* species, *L. alatus* and *L. crocodilus*. These are, when grown, among the most elongated of the *Scopelids*, whereas in their postlarval stages they are short and clumsy of build. We may further mention the enormous alteration in shape occurring in the two species *Myctophum punctatum* and *M. Humboldti*, which change from the fairly slender larvæ with more or less pedunculate eyes and duck-billed snout often mentioned in the literature, to the two species most particularly distinguished by their high and full snout. So great, indeed, is the metamorphosis which these last undergo, that MAZZARELLI (1909, 1912) was led to include the postlarval stages among the *Stomiatidæ*, while HOLT and BYRNE (1911) refer the one to *Lampanyctus crocodilus*[2]).

The postlarval stages can only be referred to their proper species with any degree of certainty when a very abundant supply of material is available, and even then satisfactory results may not always be attained. The most important point of all is to have that stage of the whole series from larva to adult which I have called the metamorphosis stage. By this I understand the stage in which the individual combines some of the purely postlarval characters, as expressed, *inter alia*, by the presence of the melanophores characteristic of the species, with some of the purely adult characters, as expressed, *inter alia*, by the presence of the photophores characteristic of the same. Nearly all writers, in describing postlarvæ of *Scopelids*, have lacked these metamorphosis stages, and it is therefore not surprising that they have found it impossible to refer the postlarval stages dealt with to their proper species (I am here referring, of course, only to such species as I have myself had an opportunity of investigating). Thus EMERY (1883), FAGE (1910), HOLT and BYRNE (1911), MAZZARELLI (1909 and 1912), and REGAN (1916) had not suitable material to work with; HOLT (1898), on the other hand, had suitable material of *Myctophum glaciale*, and the postlarval stages of this species are the first which have been correctly described under their proper specific name.

It is owing to the abundance of material brought back by the "Thor" from the Mediterranean, and to this alone, that I have succeeded in identifying the most of the *Scopelid* postlarvæ with their proper species; a lengthy and troublesome piece of work, which obviously had to be done before commencing to deal with the material biologically.

Apart from the very representative character of the material, it was naturally also an advantage that I had only to deal with the limited number of species of the Mediterranean, whereas writers handling material from the Atlantic would have a far greater number of species to choose between in classifying the postlarval stages. In determining the species of the various postlarval stages, I have had recourse to the following:

[1] Meddelelser fra Kommissionen for Havundersøgelser, Serie Fiskeri, Bind I, No. 4. Copenhagen 1905.
[2] The correct view is given by SANZO 1914—15.

1. Metamorphosis stages.
2. Continuous series from abt. 5 mm to specimens exhibiting all adult characters.
3. Number of rays in anal, dorsal and pectoral fins.
4. Number of vertebræ.
5. The limited number of species found in the Mediterranean up to date.

The number of vertebræ was determined by examination of specimens split with the blade of a safety razor, stained in alizarine, and clarified with xylol. In the case of some species, it was very difficult to arrive at a certain result, as the specimens had been preserved in formol solution for a number of years; in some species, counting of the vertebræ proved unsuccessful.

A point of some value in gauging the correctness of my determinations was the fact that adult stages of three species had been taken in the Sea of Marmora, and also, the very postlarval stages which I had referred to those species. There are, moreover, several biological features which tend to confirm the results of my determinations of species. In the case of one or two species, metamorphosis stages were not found, but, as will be seen in the special section, under the respective descriptions, there can hardly be any doubt that the postlarval stages in question must be referred to the species named (*Myctophum Rissoi*, *Myctophum Coccoi*, and *Lampanyctus crocodilus*).

Unfortunately, I was not able to find such indubitable characters in the melanophores in postlarval stages of *Myctophum Benoiti* and *Myctophum Hygomi*, as would serve to distinguish these two species one from another in the smaller stages. The oldest postlarval stages are easily distinguishable (by size, no. of vertebræ, degree of development in the fin rays, etc.), but the smaller the specimens, the more difficult, of course, it will be to make distinction. I have accordingly, in view of the uncertainty prevailing in separating these two species, to some extent taken their postlarval stages under one head, and can only hope that further, fresh material may subsequently reveal characters sufficing for a definite distinction between the two.

In the brief descriptions of the postlarval stages here given under the head of each species, and accompanied by semi-schematic drawings — these latter only intended to show the approximate shape of the postlarvæ, and the position of the melanophores — I have employed the following terms for the pigmentation (according to the above-mentioned work by JOHS. SCHMIDT, p. 4—5).

1. Occipital pigment.
2. Abdominal pigment.
3. Præanal pigment. (This term I have used in a somewhat broader sense than given by SCHMIDT; it must here be taken as covering not only the melanophores situated ventrally in front of the anal to the throat but also the (generally paired) melanophores which follow the curve of the intestine; in the somewhat older stages of certain species, these lie a little up on the side).
4. Dorsal pigment.
5. Ventral pigment.
6. Mediolateral pigment.
7. Lateral pigment.

There will also be found, in the separate descriptions, expressions such as internal pigment, supracaudal pigment, infracaudal pigment, etc. used for the purpose of indicating more exactly the appearance, position, etc. of the single melanophores.

4. The typical metamorphosis stages, and biological features pertaining thereto.

As pointed out elsewhere, I have to a great extent availed myself of the stages which I call metamorphosis stages, for the purpose of identifying the postlarvæ from the Mediterranean found in the material. By the metamorphosis stage I understand, as explained in the chapter on postlarvæ, the stage at which the individuals com-

bine some of the purely larval characters, as expressed, *inter alia*, by the presence of the melanophores characteristic of the species, with some of the purely adult characters, as expressed, *inter alia*, by the presence of the photophores characteristic of the species. There are a number of such transitional links between the postlarval and the adult stages; unfortunately, however, I have not had such in the case of all species. There are some species in the material, as for instance *Lampanyctus maderensis* and *Lampanyctus crocodilus*, which for a long time after metamorphosis retain traces of the postlarval melanophores; most species, however, especially the *Myctophum* species, evidently lose the remains of postlarval melanophores soon after metamorphosis. The postlarvæ of some species can, before metamorphosis sets in, have already a number of photophores indicated beyond those formed at a very early stage in certain species (*Brr*, hindmost *PO* and the one *PVO*) so that we can already at this stage discern what species we have to deal with (this applies especially to *Diaphus* species).

In going through these metamorphosis stages, my attention was soon drawn to certain forms which I will call the typical metamorphosis stages. These typical metamorphosis stages are distinguished by the presence not only of the postlarval pigment, but also of most of the photophores; in appearance, however, they are still far more of the postlarval type than of the adult, the adult pigment being only apparent as a darker shading, especially on the head, down the back, and on the anterior portion of the body, while the dark-pigmented stomach also, rarely shows through so strongly as in the adults. A further characteristic always noticeable is the extreme thinness, the postlarva having entirely lost its chubby, pot-bellied appearance, and being much shrunken especially in the abdominal region; this is still discernible in the smallest adult specimens. These typical metamorphosis stages afford, as mentioned, the best means of establishing connection between the series of postlarvæ and that of adults; unfortunately, however, the great material of 16,951 postlarvæ contained but very few indeed of these particular stages, only 77 in all, or abt. 0.5 %, the greater part of these having been taken during the summer cruise (one specimen picked up on the shore near Messina).

It struck me as remarkable, that among nearly 17,000 postlarvæ there should be so few of these stages. The cause might seem to be that the "Thor" had not fished in the right places at the proper season; this explanation, however, would not suffice, as the "Thor" actually worked over the principal area of distribution for *Scopelids* (the Alboran Sea and the Balearic Sea) in the months of February, June and September. I then found, that nearly all these typical metamorphosis stages were taken at the greater depths, with 1000 m. w. or more. Now the number of fishing hours on the cruise with this length of wire or beyond amounted to hardly 26 % of the total number of fishing hours, which to some extent explains the peculiarity. The finds of these typical metamorphosis stages are shown in the tables below. The first shows the numbers of the different species on the winter cruise and on the summer cruise; the second gives the depths at which these stages were taken, and the third the number, species, and depths for those stations at which more than one species were taken, as we have here some sort of guarantee that the specimens were not drawn into the net while hauling up, but actually were taken at the depth indicated.

Species	No. on winter cruise	No. on summer cruise
Myctophum Rissoi.....	"	"
" glaciale	"	6
" Benoiti.....	1	30
" Hygomi.....	4	"
" punctatum ..	"	11
" Humboldti ..	"	1
" Coccoi	"	"
Diaphus Dofleini	1	7
" Gemellarii	2	"
" Rafinesquei	1	"
" Holti.....	"	5
Lampanyctus maderensis.	"	5
" elongatus ..	1 *)	1
" crocodilus .	"	"
" alatus	"	1
Total...	10	67

*) From Capt. HANSENS collection, Messina, March 1911.

It is at once noticeable, that most of the typical metamorphosis stages were taken during the summer cruise; that by far the greater part were taken with 1200 or 2000 m. w.; that this applies to all stations where more than one species were taken; and finally, that the metamorphosis stage of a species does not appear to occur for instance exclusively at depths where it can be taken by 2000 m. w. but may be met with at various depths.

It must further be added, that at Stations 10, 106 and 122, the depth fished by 1200 m. w. was the greatest

M. W.	M. Rissoi	M. glaciale	M. Benoiti	M. Hygomi	M. punctatum	M. Humboldti	M. Coccoi	D. Dofleini	D. Gemellarii	D. Holti	D. Rafinesquei	L. maderensis	L. elongatus	L. crocodilus	L. alatus	Total
300	..	..	..	..	..	..	..	1	2	..	..	..	..	..	..	3
1000	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1
1200	..	2	2	1	1	..	..	5	..	4	1	2	..	..	..	18
1400	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	2
1600	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	1
2000	..	4	29	..	10	1	..	2	..	..	..	3	1	..	1	51
Total...	0	6	31	4	11	1	0	8	2	5	1	5	1	0	1	76

Length of wire in metres	St. 10	St. 106	St. 107	St. 108	St. 115	St. 122	St. 206	St. 209
1200	M. Benoiti . . . 1 „ Hygomi . . 1 D. Rafinesquei 1	M. Benoiti . 1 D. Dofleini . 5				M. punctatum . 1 L. maderensis . 2		
2000			M. glaciale . . . 4 „ Benoiti . . . 3 „ punctatum . 3 L. elongatus . . 1	M. Benoiti . . . 1 „ punctatum . 6 L. alatus 1	M. Benoiti . 5 D. Dofleini . 2		M. Benoiti . . 20 „ Humboldti 1 L maderensis 2	M. punctatum . 1 L. maderensis . 1

depth fished at these stations; at stations 107, 108 and 115, hauls were made with 300 m. w. and with 2000 m. w., not with intermediate lengths; at Stations 206 and 209, hauls were also made with 1000 m. w. but no typical metamorphosis stages were taken at this depth.

It will be natural, then, to examine the hydrographical conditions at these eight stations. Fortunately enough, we have whole series of observations from the seven of them; none, however from the winter station no. 10 (see J. N. NIELSEN: Hydrography of the Mediterranean and Adjacent Waters)[1]).

I have therefore, in the following table noted the values given in the Report for temperature, salinity and specific gravity (for these values, $t°$, $S\,{}^0/_{00}$ and σ_t, see l. c. p. 54); chlorine and oxygen content I have not included, as these do not appear to be of any importance in the present connection. I have taken the depths of 0 metres, 150 metres, and 600 or 1000 metres, as it has been found that the postlarvæ keep exclusively, or at any rate mainly, to the upper 150 metres or so, and the depth at which the typical metamorphosis stages are taken will probably be about half the length of wire used.

Station no.	St. 10			St. 106			St. 107			St. 108			St. 115			St. 122			St. 206			St. 209		
No. of typical metamorphosis stages	3			6			11			8			7			3			23			2		
Depth where hydrogr. observations taken	„	„	„	0	150	600	0	150	1000	0	150	1000	0	150	1000	0	150	600	0	150	1000	0	150	1000
$t°$	„	„	„	20.92	13.03	12.91	21.26	12.92	12.88	21.00	13.01	12.88	21.92	13.14	12.84	19.46	13.35	12.98	24.90	13.02	12.83	24.50	12.90	12.80
$S\,{}^0/_{00}$	„	„	„	36.56	38.19	38.37	36.92	38.30	38.37	36.53	38.19	38.37	37.30	38.26	38.36	38.30	38.46	38.39	37.39	38.26	38.37	38.10	38.33	38.37
σ_t	„	„	„	25.74	28.88	*29.03*	25.91	28.98	*29.04*	25.68	28.88	*29.04*	26.00	28.91	*29.04*	27.45	29.02	*29.04*	25.21	28.93	*29.05*	25.86	29.01	*29.06*

The soundings at these stations varied between 1100 and 2860 m.

We find then, that the typical metamorphosis stages, without regard to the temperature, salinity and specific gravity of the water layers in which they otherwise live as postlarvæ, are only taken, whether at a depth

[1] Report on the Danish Oceanographical Expeditions 1908—1910 to the Mediterranean and Adjacent Seas. Vol. I. Copenhagen 1912.

of 600 or of 1000 metres, in water where the values for temperature lie between 12.80° and 12.98°, for salinity between 38.36 ‰ and 38.39 ‰, and for specific gravity between 29.03 and 29.06.

There can thus hardly be any doubt that the *Scopelids*, when metamorphosis sets in, undergo a thorough change, acquiring a different specific gravity to that which they had as postlarvæ, and consequently move down, either actively or passively, to water layers of a specific gravity suitable to their requirements during metamorphosis, and later, after the metamorphosis is completed, ascend once more to the upper layers. In other words, we have here a decided instance of (passive or active) ontogenetic migration.

The stages immediately following metamorphosis also, as we shall later have occasion to note, are found to an essential degree at greater depths (see for instance under *Myctophum glaciale* and *Lampanyctus maderensis*).

That the specific gravity may be the only determining factor in this change of residence would certainly seem natural enough when we consider the sudden change which takes place in the postlarva; its transformation from the chubby and pot-bellied stage to the thin and shrunken metamorphosis stage, and also the alteration in detail discernible, for instance especially in the pectoral fin, which from the large, broad floating organ of the postlarva passes over into the long thin fin of the adult fish. The metamorphosis stage forms the abrupt transition from the denatant existence of the postlarva to the life of the adult, which is characterised by active movement.

It is possible that this may be the reason, or one of the reasons, why *Scopelids* (and other fishes with similar luminous organs) are not found in shallow water, but only over greater depths. As to the subsequent fate of those postlarvæ which are carried by the currents in to shallower parts of the Mediterranean, we can say nothing at present.

Of the remaining stations where typical metamorphosis stages were found, there is one from which, as from St. 10, no hydrographical observations are available; most of the others have values for specific gravity close to the limits mentioned above (from 29.05 to 29.11); only in one or two cases are the figures at all considerably wide of these. At St. 46, a metamorphosis stage of *Diaphus Dofleini* was taken with 300 m. w.; the value for specific gravity at the depth probably fished was 28.37, i. e. differing not a little from those above noted. At St. 175, in the Sea of Marmora, two metamorphosis stages of *Myctophum glaciale* were taken with 1200 m. w.; the specific gravity here at the depth probably fished was 28.88. We can, however, doubtless disregard these isolated instances, as various factors may here have been at work; in any case, it seems fairly certain that the above result can be taken as generally applicable.

In the Atlantic material which I have examined, there were a considerable number of typical metamorphosis stages, partly those of the species mentioned above, and partly others (e. g. *Myctophum laternatum* and *Myctophum Andreæ*). In this Atlantic material — which is still, however, far from finished with — I found metamorphosis stages in 27 samples, all of which were taken with from 1000—3000 m. w. By way of example, I may here mention one sample taken by the "Thor" on the 5th June 1906 at 50°25′ N, 12°44′ W, with the young-fish trawl working on 1500 m. w. This sample contained 16 typical metamorphosis stages of *Myctophum glaciale*, and 4 typical metamorphosis stages of *Myctophum punctatum*, besides some few other fish, which showed that the catch had been made at great depth. (Cf. Holt 1898).

In all probability, the specific gravity at the depth where metamorphosis stages are taken will be found to differ at different localities; it is likely that the specific gravity of the water layers in which the fish lived as postlarvæ will here be of importance.

Finally, I would call attention to the fact that a certain downward trend may be discerned already in the movement of the largest postlarval stages; with regard to this, however, reference must be made to the special section, where the fact is mentioned in connection with several species, and the whole question discussed from various points of view.

It seems then, that the very slight percentage (abt. 0.5 %) of typical metamorphosis stages in the great mass of postlarval material must doubtless in part be accounted for by the fact that the expedition did not work so long at these greater depths as in the upper water layers where postlarval stages are found. The process of

metamorphosis itself, again, must be presumed to take place fairly rapidly, and this might also be a contributory cause. One of the chief factors, however, is more likely this: that the postlarvæ, which are found for the most part in the upper 150 metres of water, will during their ontogenetic migration spread out over water layers of far greater thickness, whereby the chance of catching them is proportionately diminished.

It may be added, nevertheless, that a good half of the hauls made at sufficient depth (with over 1000 m. w.) in places where the specific gravity was near that found, yielded one or more typical metamorphosis stages. And it is further possible that the nets actually worked only on the upper limits of water layers where a maximum of typical metamorphosis stages actually occurred. We may therefore expect that other expeditions, by fishing with suitable implements at the proper depth, will be able to procure a far greater number of these metamorphosis stages, and thus render it possible to identify the numerous postlarvæ which make up so great a part of the plankton in the open sea.

The same thing would seem to apply in the case of the postlarval stages of other fishes with luminous organs on transition to the more adult appearance (see VILH. EGE: *Stomiatidæ* (*Stomias*) in this Report, vol. II, A. 4).

5. Number of vertebræ in the genus Myctophum.

With a genus such as *Myctophum*, comprising a great number of species differing but little one from another, it is of the greatest importance to have as many characters as possible to work with. The earliest investigators have based their characterisation of the species chiefly upon the number of fin rays, position of the fins, length of the head etc. in proportion to other dimensions. In dealing with a small number of species, such characters will be valuable enough; most of the Mediterranean *Myctophum* species, for instance, might be identified thereby. But where a great number of species are concerned, the characters named will not suffice, and RAFFAELE's introduction of the position of the photophores as a specific character (1889—91) marked an enormous advance. The full importance of this, however, was first realised in the extremely valuable treatise by LÜTKEN (1892) followed by BRAUER's indispensable work, wherein the material of this genus from the "Valdivia" is compared with that previously on record in the literature or otherwise available (1906).

In the present work, though chiefly concerned with the biological aspects, I have further sought to introduce another useful character, the number of vertebræ, which, albeit far inferior to the photophores, will nevertheless in certain cases be found of value. As far as I am aware, there is nothing in extant literature concerning the number of vertebræ in the genus *Myctophum* save for a brief note by REGAN (1911) who states that *Lampanyctus* (species not named) has 35 vertebræ. I have in the present work, as will be seen, here and there employed the number of vertebræ *inter alia* to demonstrate the existence of racial differences between one or two species in different areas (e. g. between the Atlantic and the Mediterranean, or between different areas within the limits of the Mediterranean itself) and in identification of the postlarval stages. It was originally these special biological investigations which led me to adopt the method of counting the vertebræ, but as the character proved of value, I considered it best to include as many countings as possible.

The counts were always made upon adult specimens, which were split lengthways with the blade of a safety razor, stained in an alizarine solution, clarified in xylol, and examined under the microscope; the figures obtained are thus fully reliable[1]). Altogether, countings of vertebræ were made with 674 specimens, representing 14 species. Of these, 624 are noted in the subjoined table, the remaining 50 are shown under their respective species in the special section (*Myctophum glaciale* from the Sea of Marmora).

It was soon found that the number of vertebræ in specimens from the Mediterranean did not always agree with that in specimens from the Atlantic, and differences were at the same time noted in respect of other characters (no. of *AO* and of fin rays) in *Myctophum glaciale*, as shown elsewhere. I have therefore as far as possible included in the table countings made with specimens from the Atlantic[2]) taken by the "Thor", the "Margrethe"

[1] I have throughout noted the total no. of vertebræ, as it is often difficult exactly to determine the limit between præcaudal and caudal vertebræ (the former are, however, probably always 15—16 in number).

[2] Specimens from the Bay of Cadiz or nearest parts of the Atlantic have in no case been used.

	Myctophum													
	Rissoi		Benoiti		Hygomi		glaciale		punctatum		Humboldti		Cocco	
Vert. no.	M.	A.	M.	A.	M.	A.	M.	A.	M.	A.	M.	A.	M.	
42	..	..	..	..	..	..	..	..	..	*1*				
41	..	..	..	..	..	..	..	..	..	*5*	..	..	5	
40	..	..	..	..	..	..	..	..	20	*1*	16	..	5	
39	..	..	..	..	..	..	..	..	..	..	7	..	..	
38	..	..	..	..	..	..	..	..	..	..	..	*7*	..	
37	..	..	..	*1*	19	..	..	*2*	..	..	..	*6*	..	
36	..	..	16	*8*	1	..	4	*32*	..	..	..	..	..	
35	..	..	4	..	..	..	40	*16*	..	..	..	..	..	
34	..	*12*	..	..	..	..	6	..	..	..	..	..	..	
33	12	*2*	..	..	..	..	..	..	..	..	..	..	..	
32	..	..	..	..	..	..	..	..	..	..	..	..	..	
Total	12	*14*	20	*9*	20	*0*	50	*50*	20	*7*	23	*13*	10	
Mean	33.000	*33.857*	35.800	*36.111*	36.950	?	34.960	*35.720*	40.000	*41.000*	39.696	*37.538*	40.500	

M: Mediterranean. A: Atlantic.

or some other vessel for purposes of comparison. In most cases the numbers are but small, as the Atlantic material in the present stage of treatment cannot well be taxed to serve other purposes. I hope in a later work, to return to this point, and make comparison between the Mediterranean and Atlantic species. I will merely note here, that a possible establishment of racial difference will affect *Myctophum Hygomi*, *Myctophum glaciale*, *Lampanyctus maderensis*, and *Lampanyctus alatus*, these being the only Mediterranean species described after species from the Atlantic. Of these four species, I have not had access to material of *Myctophum Hygomi* and *Lampanyctus maderensis*; in the case of *Myctophum glaciale*, I have separated the Mediterranean form as a distinct race; and I have shown, by countings of vertebræ, that *L. alatus* is probably represented by one and the same form in the Atlantic and Mediterranean.

As will be seen from the table, the number of vertebræ is often higher in the Atlantic than in the Mediterranean (*Myctophum Rissoi*, *M. Benoiti*, *M. glaciale*, *M. punctatum*, *Diaphus Rafinesquei*, *Lampanyctus elongatus* and *L. crocodilus*) but may also almost coincide for both (*Myctophum Coccoi*, *Diaphus Dofleini* and *Lampanyctus alatus*) or even be lower in the Atlantic form (*Myctophum Humboldti*). Naturally, these countings, which in the case of most species are all too few, can only be regarded as temporary indications; even as such, however, they tell us something. They show, for instance, how careful we must be in comparing individuals or their biological features from the two waters concerned. *Myctophum Humboldti*, for instance, with its markedly characteristic position of the photophores, etc. has been regarded as one and the same species in Atlantic and Mediterranean; the striking difference here observed in the number of vertebræ, however, would seem to render the identity somewhat doubtful.

The number of vertebræ varies greatly within the genus. The species here dealt with embrace a range of values for this character extending from 32 to 42 both inclusive. Within the three groups, *Myctophum*, *Diaphus*, and *Lampanyctus*, again, we find considerable variation (compare, for instance, *Myctophum Rissoi* with *Myctophum Coccoi*, and *Lampanyctus alatus* with *Lampanyctus elongatus*), least within the *Diaphus* group. The number of vertebræ is often, though by no means always, connected with the shape of the body: *Myctophum Rissoi* has a small number of vertebræ, *Myctophum Coccoi* a greater number, but *Lampanyctus alatus* only few. Each species by itself appears to have only a slight range of variations (four vertebræ at the outside), some seem to vary more than others (compare *Lampanyctus alatus*, for instance, with *Myctophum punctatum*) but this may possibly be due to the paucity of material. It is seen, then, that species which outwardly appear closely related, (as for instance *Myctophum Benoiti* and *Myctophum Hygomi*; *Diaphus Rafinesquei* and *Diaphus Holti*) may exhibit a distinct difference in the number of vertebræ.

Diaphus								*Lampanyctus*									
Dofleini		Gemellarii		Holti		Rafinesquei		maderensis			elongatus		alatus		crocodilus	
M.	A.	M.	A.	M.	A.	M.	A.	M. western	M. eastern	A.	M.	A.	M.	A.	M.	A.
			..													
			..													
..	..	..	..	..	..	..	..	..	..	..	1					
..	..	..	..	..	..	..	..	..	..	..	12	*10*				
..	..	..	..	..	..	..	..	..	2	..	7	..	..	..	..	*3*
..	..	..	..	..	..	..	..	27	64	..	..	..	..	..	10	*5*
..	..	..	..	..	..	..	..	40	19	..	..	..	..	..	13	*1*
1	*1*	..	..	..	..	..	*1*	1								
17	*15*	..	..	..	..	19	*7*	..	..	..	..	..	1	*2*		
5	*7*	..	..	24	..	3	..	..	..	..	..	..	18	*16*		
..	.	..	..	2	..	..	..	..	..	..	..	..	6	*6*		
23	*23*	0	*0*	26	*0*	22	*8*	68	85	*0*	20	*10*	25	*24*	23	9
33.826	*33.739*	?	?	32.923	?	33.846	*34.125*	36.382	36.800	?	38.700	*39.000*	32.800	*32.833*	36.435	*37.222*

As to the precise localities from which the specimens investigated were derived, reference must be made, for the Mediterranean material, to the separate sections for each species; the Atlantic material I hope to deal with in a later work.

6. Secondary sexual characters (sexual dimorphism).

Brauer has shown, that the luminous plates frequently referred to in the literature, which are found præcaudally in fully developed specimens of the *Myctophum* species, are secondary sexual characters. I have gone into this question as far as the present material permitted, and found almost without exception that the connection pointed out by Brauer as between the supracaudal plates and male sex, and between infracaudal plates and female, was also here apparent. It was further found that this character also applies to the two divergent *Diaphus* species: *Diaphus Gemellarii* and *Diaphus Dofleini*. In a single instance, a specimen of *Diaphus Dofleini* was found to have neither supracaudal nor infracaudal plates (the specimen in question measured abt. 30 mm), and on investigation of sex, it was found to be a male. In *Myctophum glaciale*, I have further found both supra- and infracaudal plates in some few individuals[1]), and a large specimen of *Myctophum Humboldti* at the Zoological Museum in Copenhagen exhibits the same feature.

With regard to possible hermaphroditism in these individuals, later investigations may perhaps afford some information, but a large amount of material will be required, preserved with this particular investigation in view, before anything definite can be said. I merely mention the point here in order to draw attention to the fact that such divergence from the otherwise constant conditions may occur. Lütken (1892) already noticed the same thing, and it was this which led him to conclude that the normal state of things could not be due to sexual difference (p. 244).

And we may here note, that a species such as *Myctophum Rissoi*, which is regarded by Brauer as a more original form, exhibits the remarkable peculiarity that the female has plates both infra- and supracaudally, while the male has no plates in either part; it might therefore seem that the few rare cases where the plates in question are found both supra- and infracaudally in other species, where it must be regarded as abnormal, represent more original conditions (cf. however *M. antarcticum*, *M. arcticum*, *M. parallelum* and *M. subasperum*).

I found that the supracaudal and infracaudal plates had their own peculiar appearance in each of the species which I examined, and I would here point out that the structure, position, etc. of these luminous plates

[1] In these, either the infracaudal or the supracaudal plate is generally more prominent than the other; an investigation of sex in three specimens showed that the most prominent secondary sexual character gave the true sex.

in mature individuals afford a character which will be of importance in determining the greater or lesser degree of relationship between the species.

Under the heading of the separate species will be found a brief description of the appearance and size of these organs in the two sexes. In closely related species there may be a considerable degree of similarity in appearance, while other closely related species again exhibit greater difference (e. g. the males of *Myctophum Benoiti* and *Myctophum Hygomi*; I have had no opportunity of examining females of the latter species). In some species, the organs are less prominent than in others, as a rule least so in the females. The organs may be of a highly prominent character, as for instance in *Myctophum Benoiti* and *Diaphus Dofleini*, and especially in *Myctophum phengodes*, in which species seven[1]) scale-shaped plates are enormously developed supracaudally.

On considering these organs and their position, we decidedly obtain the impression that they serve to lead the sexes in their search one for another; and it will also probably be natural to suppose, with BRAUER, that in these species, which doubtless live for the most part in twilight, the photophores afford specific marks which keep individuals of one species together, and, at any rate in the case of certain species, enable them to keep in shoals; possibly, however, not all these organs have the function in question (the antorbital and suborbital, for instance). That the organs in the female are situated infracaudally might seem to suggest that the males pursue them from below and behind, as is often seen to be the case among fish (e. g. several *Cyprinodonts*).

Only in two species of the *Diaphus* group have similar secondary sexual characters been found; the great majority of species in this group, as in the *Lampadena* and *Lampanyctus* also, lack the characters in question. In some species, at any rate, of the *Lampanyctus* and *Diaphus* group, the male has a slightly larger eye than the female (e. g. in *Lampanyctus alatus* and in *Diaphus Dofleini*).

7. Key to the species of the genus Myctophum

caught in the Mediterranean by the research steamer "Thor" (after BRAUER).

Abbreviations:

PO	=	Maculæ	pectorales.	*Prc*	=	Maculæ	præcaudales.
PVO	=	—	subpectorales.	*PLO*	=	—	suprapectorales.
VO	=	—	ventrales.	*VLO*	=	—	supraventralis.
AO	=	—	anales.	*SAO*	=	—	supraanales.
AO ant.	=	—	anales anteriores.	*Antorb.*	=	—	antorbitales.
AO post.	=	—	anales posteriores.	*Suborb.*	=	—	suborbitales.
Pol	=	—	posterolaterales.	*Brr.*	—	—	branchiostegæ.

P = pectoral, *A* = anal, *D* = dorsal. *V* = ventral, *C* = caudal.

1. Subgenus Myctophum.

Photophores not divided by a black septum, no luminous scales; in specimens which have attained or are nearing maturity, secondary sexual characters are apparent in luminous plates infra- or supracaudally. *PO*, *VO* and *AO* generally at the same level; more rarely, the penultimate *PO* and second *VO* thrust dorsally out from the series; *AO* in one or two groups; always 2 *Prc*; the orbital photophores small; *D* shorter than *A*.

I. Cleft of the mouth extends to the vertical of posterior margin of the eye, maxillaries greatly expanded behind, eye very large, snout not projecting.

1. Pol lacking, *AO* in one group. *AO*: 10—12. *M. Rissoi.*
2. Pol: 1. *SAO* in an obtuse angle. *AO*: 5—7 + 5—7, as a rule 6 + 6. *M. glaciale*[2]).
3. Pol: 2. *SAO* in an obtuse angle.

[1] This figure is of frequent occurrence in connection with these organs.

[2] The related species *Myctophum laternatum*, Garm. which is possibly found in the western basin of the Mediterranean, is distinguished by having *SAO* in an oblique line, and *AO*: 5—7 + 2—3.

a. Last *Prc* and *VLO* ventrally from lateral line. *AO*: 4—7 + 5—8, as a rule 5 + 6, 5 + 7 or 6 + 6. *M. Benoiti.*

b. Last *Prc* and *VLO* close to lateral line. *AO*: 6—8 + 5—7, as a rule 7 + 6. *M. Hygomi.*

II. Cleft of mouth always reaches behind the vertical of posterior margin of the eye, maxillaries only very slightly broadened behind, eye medium size. Pol 1, *AO* always in two groups.

1. Snout not projecting.

a. *SAO* in an oblique line. *AO*: 7—9 + 7—9, as a rule 8 + 8 or 8 + 9. *M. punctatum*[1]).

b. *SAO* in an obtuse angle. *AO*: 7—9 + 7—9, as a rule 8 + 8 or 8 + 7. *M. Humboldti.*

2. Snout projecting. *SAO* in an obtuse angle. *AO*: 5—7 + 12—13, as a rule 6 + 12. *M. Coccoi*[2]).

2. Subgenus: Lampadena (Goode and Bean).

Photophores divided by a black septum, both infra- and supracaudally there is a large luminous plate, no luminous scales; first *PO* and the two *PVO*, like the first three *VO*, do not form a straight, obliquely ascending series; both *PVO* and *PLO* lie one above another in the same vertical, 3—4 *Prc*, 1 Pol; *SAO* in a steeply sloping line; last *Prc* in the lateral line. *D* and *A* of equal length. (No. species taken in the Mediterranean).

3. Subgenus: Diaphus (Eigenmann and Eigenmann).

Photophores divided by a more or less distinct black septum; luminous plates (secondary sexual characters) may be present or lacking; luminous scales not found præcaudally, often a luminous scale at *PLO*. *PO*: 5, the penultimate always out of the series; both *PVO* form, together with the first *PO*, a straight series rising obliquely towards the base of the pectoral; between first and second *PO* there is always a greater interval. *VO* always 5; the three first *VO* likewise form a straight series rising obliquely. *AO* in two groups (as a rule 4—6 and 4—6); Pol always 1; *Prc* always 4; *PLO* always dorsal to base of *P*; *SAO* always in a steep oblique line; no organs dorsally to lateral line. 1—2 Antorb. and at times 1—2 Suborb., often very strongly developed.

I. Antorb.: 1 small over the nostril. Secondary sexual characters expressed in luminous plates supra- or infracaudally.

1. Last *AO* ant. not thrust much up towards the lateral line. Last *Prc* distant a good way from the first three *Prc*. *AO*: 4—6 + 4—6, as a rule 5 + 5. *D. Dofleini.*

2. Last *AO* ant. thrust much up towards the lateral line, giving the appearance of 2 Pol. Last *Prc* not unusually distant from the first three *Prc*. *AO* as a rule 5 + 6. *D. Gemellarii.*

II. Antorb.: 1 dorsally to nostril, Suborb. 2; all strongly developed. No luminous plates supra- and infracaudally. Luminous scale at *PLO*[3]).

1. Both first and last *AO* ant. thrust dorsally out of the series. Posterior Suborb. small and in connection with the elongated organ in front. *AO*: 5—7 + 3—5, as a rule 6 + 4. *D* has as a rule 13, *A* generally 14 rays. *D. Rafinesquei.*

2. First *AO* ant. in a series with the rest, the last thrust dorsally out of the series. Posterior Suborb. large, circular, distinctly separated from the elongated organ in front. *AO*: 4—5 + 3—5, as a rule 5 + 4. *D* has a rule 14, A generally 13 rays. *D. Holti* sp. n.

4. Subgenus Lampanyctus (Bonaparte).

Photophores not divided by a black septum, always luminous scales supra- and infracaudally, at times also on other parts of the body, *Pol* 2, *AO* always in two groups, *PLO* always dorsally to pectoral. Maxillaries only slightly broadened behind, cleft of the mouth always reaches far behind the posterior margin of the eye.

[1] *Myctophum affine* (Lütken) is distinguished from this by having *AO* post. all situated behind *A* (which is not the case in *M. p.*) and *AO*: 7—10 + 3—6.

[2] *Myctophum Andreæ* (Lütken) is distinguished from *M. Coccoi* especially by having *SAO* in a steep oblique line nearly down to posterior *VO*, and by having short gill-rakers, whereas in *M. Coccoi* they are long.

[3] *Diaphus metopoclampus* (Cocco) is easily distinguished from the above two species by the very strong development of the frontal photophores (see fig. 25—26) and by the number of fin rays: *D*: 15, *A*: 15.

A. Luminous scales are found præcaudally and on other parts of the body. Photophores roundish. *Prc* distinctly separate from *AO* post.

1. 2 *Pol* obliquely one over the other. On the forehead a horizontal spine above the orbit. *D* and *A* equally long. *AO*: 5—7 + 5—7, as a rule 6 + 5 or 6 + 6. *L. maderensis.*
2. 2 *Pol* in series. No. frontal spine. *D* much longer than *A*. *AO*: 7—9 + 6—7, as a rule 8 + 6 or 9 + 7. *L. elongatus.*

B. Luminous scales found only præcaudally or at the utmost one luminous scale also at base of the adipose fin. Photophores kidney-shaped. *Prc* not sharply separated from *AO* post. (as *Prc* are reckoned in these two species only the two last photophores situate at the base of the caudal fin and higher than *AO*).

1. One photophore on the cheek. *P* reaches to or nearly to the posterior margin of *A*. Last *Prc* above and in front of the penultimate. Minute photophores are found spread over the entire body. No luminous scale at base of adipose fin. *AO*: 4—6 + 7—9, as a rule 5 + 7, 4 + 8 or 5 + 8. *L. alatus.*
2. As a rule three photophores on cheek. *P* does not reach so near the posterior margin of *A*. Last *Prc* straight above the penultimate. No minute photophores spread over whole body. A luminous scale at base of adipose fin. *AO*: 6—8 + 8—11, as a rule 7 + 10 or 7 + 9. *L. crocodilus*[1]).

8. Key to the postlarval stages of the genus Myctophum
taken in the Mediterranean by the research steamer "Thor".

In this key, attention has chiefly been paid to the larger postlarval stages; for the smaller and smallest ones, reference must be made to the treatment of these under the separate species in the special section. For pigmentation *vide supra* (p. 17).

I. Eye oblong, with a tapering prolongation of the lower margin[2]). The larval marginal fin-fold is present up to the oldest stages or at any rate, remains of it are preserved (the dorsal sinus)[3]). *Myctophum.*

A. The "eye-taper" less strongly developed; lower margin of the eye turned forward, so that the eye lies in a markedly oblique position. Only a few melanophores present (præanally), none on the anal papilla. Metamorphosis takes place at abt. 9 mm (without caudal fin). *M. Rissoi.*

B. "Eye-taper" more strongly developed, but partly disappears immediately prior to metamorphosis. The metamorphosis takes place at a length of abt. 10 mm or over.

a. "Eye-taper" pigmented.

1. Smaller postlarvæ, the metamorphosis stages lies at lengths below 15 mm. Snout not unusually flattened in the smaller stages.

α. Strong pigment on posterior border of operculum, below the angle of the lower jaw, on the points of the snout and of the lower jaw. Anus in smaller stages slightly in front of the anal fin. Metamorphosis takes place at 10—11 mm. *M. glaciale.*

β. No pigment, or at any rate only slight, on the posterior border of the operculum, under the angle of the lower jaw, on the point of the snout, and point of the lower jaw. Anus in all stages immediately at the anterior margin of the anal fin.

0. Metamorphosis takes place at a length of 10—12.5 mm. *M. Benoiti.*

00. Metamorphosis takes place at a length of 13—14.5 mm. *M. Hygomi.*

2. Larger postlarvæ. Metamorphosis takes place at lengths over 15 mm. The snout in smaller stages very markedly flattened, not unlike a duck's bill.

[1] *Lampanyctus gemmifer,* Goode and Bean, is most easily distinguished from *L. crocodilus* by the fact that it has no luminous scale at the base of the adipose fin, and only two photophores on cheek.

[2] This has been described in detail by BRAUER (1908) p. 167—169, Fig. IV, and Fig. 16—17, Pl. XXXVI.

[3] See HOLT (1898), p. 554—555.

α. Caudal pigment and also pigment dorsally, ventrally and elsewhere. Pectoral reaches hardly or just to the anus. Metamorphosis at 17.5 to 19.5 mm. *M. punctatum.*

β. Without pigment caudally, dorsally or ventrally. Pectoral reaching far beyond the anus. Metamorphosis at abt. 20 mm. *M. Humboldti.*

C. "Eye-taper" not pigmented, but finely striped longitudinally, very long. Caudal, ventral and dorsal pigment. Metamorphosis stages lie between 12 and 17 mm (none of these found in the material dealt with). *M. Coccoi.*

II. The eye entirely or almost circular, with no marked "eye-taper". The larval marginal fin-fold disappears already in the smaller stages; no remains of the dorsal sinus are found in the older stages. *Diaphus* and *Lampanyctus.*

A. There is only a little pigment, or none at all, dorsally to the lateral line, at any rate in the caudal region. There is as a rule a melanophore at the posterior margin of the anal fin. Smaller postlarvæ. *Diaphus.*

a. Eye small (especially in *D. Dofleini*). Upper rays of the pectoral fin more or less markedly prolonged.

1. Without melanophores at base of caudal. The upper rays of the pectoral less markedly prolonged. Metamorphosis at 10.5—13 mm. *D. Dofleini.*
2. Two sharply distinct melanophores at base of caudal. Upper rays of the pectoral greatly prolonged. Metamorphosis at 13.7 to 14 mm. *D. Gemellarii.*

b. Eye not unusually small. No prolonged rays in upper part of pectoral.

1. A melanophore at base of caudal in the lower part, also pigment between the posterior margin of the anal and the caudal. Metamorphosis at 10 mm. *D. Rafinesquei.*
2. Two melanophores at base of caudal, no pigment between posterior margin of anal and caudal. Metamorphosis at 10—12 mm. *D. Holti* sp. n.

B. Dorsal, ventral and at times also mediolateral pigment found. Larger and smaller postlarvæ. *Lampanyctus.*

a. 3—4 prominent melanophores both supra- and infracaudally. Shape very elongated. Metamorphosis at 15—22 mm. *L. maderensis.*

b. No melanophores both supra- and infracaudally. Shape rather short and clumsy.

1. Pigment stripes dorso-, medio- and ventrolaterally, at any rate behind the vertical of the anus. Metamorphosis at 19.5—21.5 mm. *L. elongatus.*
2. Not pigment stripes both dorso-, medio- and ventrolaterally, at any rate, only two of them. One unpaired melanophore usually present between the dorsal and the adipose fin.

α. With fainter dorso- and mediolateral pigment stripe. Scattered pigment over most of the body. Extremely short and clumsy. Metamorphosis at abt. 12 mm. *L. alatus.*

β. Markedly prominent transverse pigment stripes above and behind the pectoral, (following the myotomes). Metamorphosis at abt. 19—22 mm. *L. crocodilus.*

B. Special Section.

Subgenus *Myctophum*.

MYCTOPHUM RISSOI (Cocco).

Vert: 33; D: 12, *13*, *14*, 15; A: 16, 17, *18*, 19; P: 15, *16*, 17; V: 8.

Material. Of this species, we have from the Mediterranean itself 125 specimens, of which 105 are postlarval stages, and only 20 adults. The species is thus rather poorly represented. From the Atlantic, I had a smaller amount of material at my disposal.

Literature. This characteristic species was described by Cocco (1829) from the Mediterranean; it is well known from there (Messina) and is consequently mentioned by several writers dealing with these waters. EMERY (1883) has described what he (with a query) believed to be the postlarva of this species (fig. 7 and 8), but was in error; his figures (7, 8 and 9) must be referred to a couple of *Diaphus* species. See also BRAUER (1906).

Postlarval characters.

9 mm. (11 mm incl. caudal). This stage, which must be supposed to come a little before the metamorphosis stage, may be characterised as follows. Shape rather short and broad. Pectoral large, ventral somewhat developed; the anal and dorsal have, like the pectoral, their specific number of rays distinctly developed, though they have not yet reached the length subsequently attained; the incurvation of the caudal not so deep as in adults. Large remains of the larval marginal fin-fold present. The eye an elongated oval, with slight taper; the lower point turned forward. Præanal pigment is present in the form of a couple of large melanophores in front of the ventral fin. There is generally pigment along the rays of the pectoral, especially towards the point; pigment is also found on the point of the snout and the point of the lower jaw. Other pigment not found in this species. Of photophores, only indication of *Brr*.

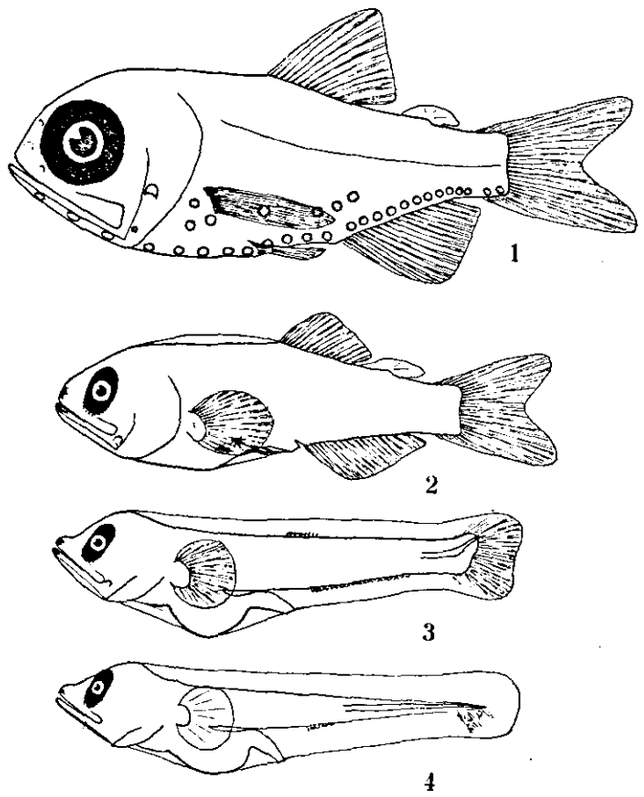

Fig. 9. *Myctophum Rissoi* (Cocco). 1: ad.; 2: 9 mm; 3: 6.5 mm; 4: 4.5 mm.

Characteristic features of this postlarva are the slight pigmentation and the long, obliquely set eye.

6.5 mm. (7). This stage has the eye obliquely set, as in the previous one; pigment is generally only visible on the points of the snout and of the lower jaw. *Brr* faintly indicated. General appearance markedly larval; the upturned portion of the notochord distinct; only indications of the base of the anal fin and forepart of base of the dorsal; main rays of the caudal developed; no trace of the ventral; the pectoral large, with rays partly

formed. The intestine makes a big curve, and the anus lies a little in front of the anterior margin of the anal fin; in the stages between 6.5 and 9 mm it is possible to observe how the anus moves farther and farther back.

4.5 mm. The tip of the notochord is straight; only slight indication of caudal fin; pectoral without formed rays, no trace of dorsal, but forepart of base of anal faintly indicated. The intestine, as in the previous stage, makes a big curve. Pigment little or none. The eye of the usual characteristic appearance.

Of this species, we have no metamorphosis stages, or stages with photophores developed in accordance with those of the adults. There can, however, hardly be any doubt that we have here the postlarva of *Myctophum Rissoi*; the number of rays in dorsal and anal is that characteristic of the species (I have counted 12—14 in D, 16—18 in *A*, and 16 in *P*); position of the anal as in the adult. No known Mediterranean species has such small adult stages (9.5 mm) corresponding to the size of these postlarvæ, (the largest is abt. 9 mm). *Brr* in the largest postlarvæ much resembles the corresponding organ in the adult; in the largest postlarvæ, the caudal part of the body is as in *Myctophum Rissoi*, and several biological features suggest that this must be the postlarva of that species. The smallest adult stage had no trace of any larval pigment remaining.

It should be pointed out that several characters appear to mark this form as among the most original types of *Scopelid* (the same is noted by BRAUER with regard to the adult stages); the preservation, for instance, of the larval marginal fin-fold in fairly large specimens must be regarded as belonging to the more original characters (cf. the remaining groups); possibly also, the position of the anal papilla (cf. *Myctophum glaciale*).

The postlarval stages of this species have not been previously described.

Adult characters.

1. No. of vertebræ. I have investigated the number of vertebræ in 12 specimens of this species from the Mediterranean, and 14 from the Atlantic. In the smallest individuals, abt. 10 mm, it was noticed that the urostyle consists of two segments, which soon, however, fuse together, so that the original bipartition will hardly be discernible in older stages; in this respect, the Atlantic and Mediterranean forms are alike. In counting the vertebræ of small specimens, therefore, I have always taken these two segments as one. Countings of vertebræ were made with 11 specimens from stations in various parts of the western basin, the figure for these was invariably 33 (15 + 18). One specimen from the eastern basin (St. 160) had the same number. In the Atlantic specimens, 34 was the most common figure. (In this connection it may be added that the maculæ anales can here number 13, a figure which I have not found in specimens from the Mediterranean).

2. No. of photophores etc. In the Mediterranean material, I counted the number of maculæ anales sin. in 19 specimens; in seventeen of these, the number was 11, while two had 12 such organs (BRAUER notes something similar); the figure 10 I found on the right side of a single specimen; only two specimens showed any difference between left and right side in the number of *AO*. In a single instance, 4 *SAO* were observed.

3. Infra- and supra-caudal luminous plates (the secondary sexual characters).

The present material shows no trace of these plates, as all the specimens are but small; the largest, measuring 32 mm (excl. caudal) had no plates, and the reproductive organs were quite undeveloped. According to BRAUER (1906) and ZUGMAYER (1911) it would seem that the male has no plates, while the female has plates both infra- and supracaudally. LÜTKEN's statement (1892 p. 249) seems hardly to agree with this, but it should be understood as meaning that some individuals have luminous plates both supra- and infracaudally (one or two) while others have none in either part. I have satisfied myself that this is the case by going through LÜTKEN's material, in which some of the specimens are not a little damaged. This extremely interesting point will, however, need to be further looked into, as it places the species in an exceptional position compared with the rest of the species of the *Myctophum* group, where the facts are better known.

The caudal fin in specimens of abt. 10 mm is about 3 mm long; in the other sizes, its length could not be determined, owing to the state of the material.

Distribution. The species is found in the Atlantic, and has been taken in the Indian Ocean.

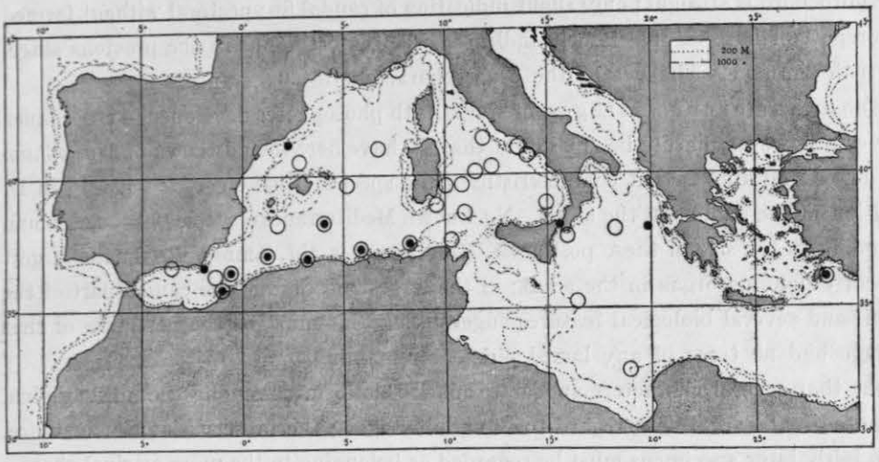

Fig. 10. Distribution of *Myctophum Rissoi* (Cocco), according to the investigations of the "Thor". ● adult stages; ○ postlarval stages.

The present material is, as mentioned, but small; it seems nevertheless to give some idea as to the distribution of the species in the Mediterranean.

As will be seen from the chart, the species was met with throughout the greater part of the Mediterranean; not, however, in the Adriatic or the Ægean. Most of the specimens, both postlarvæ and adults, were taken in the Balearic and Tyrrhenian Seas. Judging from the present material, the species seems to be of somewhat rare occurrence in the Mediterranean; though various points would seem to suggest that it may be a deeper-living form, which would doubtless partly account for the fact of its having been taken only in comparatively small numbers by this expedition. It has been taken at Messina in all months of the year (Mazzarelli 1909) especially from November to January. The largest of our present specimens is from Messina (March 1911). Like several deeper-living forms, the species does not

Metres of wire out	Postlarval stages				Adult stages			
	winter		summer		winter		summer	
	no. of sp.	pos. hauls	no. of sp.	pos. hauls	no. of sp.	pos. hauls	no. of sp.	pos. hauls
25.....	6	2						
65.....	1	1						
200.....	6	1						
300.....	33	10	45	19	6	3	2	2
600.....	4	2	..	..	2	1	1	1
1000.....	..	..	3	3				
1200.....	..	..	..	..	..	..	2	2
1600.....	2	2	..	..	1	1		
2000.....	..	..	5	1	..	..	1	1

seem to move in shoals, the greatest number of adults taken in one haul being four, all of which were small (abt. 10—12 mm).

Like the remaining *Scopelids*, this species is found almost exclusively over greater depths; from about 500 metres onward.

As regards vertical distribution, nearly all our specimens were taken with 300 metres of wire or over. This will be seen from the following table, including both postlarvæ and adult stages.

It will be noticed that some postlarvæ are found in winter fairly high up in the water (the Tyrrhenian Sea); this is, as I have shown in the following for nearly all species, a common occurrence. As regards possible vertical migrations from day to night, nothing can be said from the present material; all the adult stages were taken in night hauls, none by day.

Propagation. The present material includes no large mature individuals; in the literature, we find mention of specimens up to a length of 75—80 mm (CARUS, ZUGMAYER). From what we know of the other *Scopelids* it must be presumed that such specimens would belong to Group II(?) and that Group I would comprise the stages about 30—40 mm at which maturity should then set in.

The postlarvæ, all of which with the exception of 15 are from the western basin, were taken evenly throughout the months of January, February, June, July, August and September, fewest in June, though the vessel was working in the western basin during that month. The sizes are mostly about 7 mm; only 20 specimens fall below this figure. The distribution among the different months will be seen from the following:

Month:	Jan.	Feb.	June	July	Aug.	Sept.
No. of Postlarvæ.....	21	31	4	14	23	12

We must doubtless suppose that the species spawns all through the year, but this question, together with several others, will need further investigation.

The material contains only three specimens over 14 mm (32, 30 and 20 mm), taken in March, June and August (respectively).

As mentioned, we have no mature individuals of this species, and counting of eggs in the ovaries was therefore impossible.

MYCTOPHUM GLACIALE (Reinhardt).

Vert: 34, *35*, 36; D: 12, *13*, 14; A: 16, 17, *18*, 19; P: 11, 12; V: 8.

Material. The "Thor" material from the Mediterranean itself comprises 5005 specimens of this species; of these, 3672 are postlarvæ, and 1333 adults. This includes specimens taken in the Sea of Marmora. I have also employed a large material both of postlarval and of adult stages from the North Atlantic, collected by the "Thor", "Margrethe" and other vessels working for the Royal Danish Committee for the Study of the Sea.

Literature. *Myctophum glaciale* was described by REINHARDT in 1837. Otherwise, the species has only been mentioned four times from the Mediterranean. HOLT and BYRNE note it as taken by the "Silver Bell" off Marbella (WOLFENDEN 1909) and L. FAGE (1910) records a find off Cape Creus. It is mentioned by ZUGMAYER (1911) from the western basin. LÜTKEN, however, had small specimens of this *Scopelid* from the Mediterranean in his material (LÜTKEN 1892 p. 251; specimens taken by Dr. BRANNER in the western part of the Mediterranean, 36°29′ N, 2°28′ W) but owing to the smallness of the individuals in question, LÜTKEN did not venture to refer them definitely to this species. *Myctophum glaciale* is not mentioned in any of the Italian works; as will be seen from the following, it is also comparatively rare in the waters investigated by Italian writers.

A description of the postlarvæ was given by HOLT in 1898, and *M. glaciale* is thus the first *Scopelid* to be described with certainty in the postlarval stages.

See also BRAUER (1906).

Postlarval characters.

11 mm. (13 mm incl. caudal). This stage, which comes immediately before the metamorphosis, may be described as follows. Dorsal sinus still fairly distinctly preserved; adipose fin large, as also the pectoral; the ventral still only indicated; anal and dorsal with normal complement of rays distinctly formed, though not of full length; incurvation of the caudal less pronounced than in the adult. Eye with small remains of the taper, but no longer so markedly oval as in the smaller stages.

Occipital pigment present as an internal spot; it may be more or less marked, and of greater or lesser extent. Abdominal pigment present in the form of 1—6 large internal melanophores, as a rule abt. 3. Præanal pigment in the form of three large melanophores, the hindmost on the side of the anal papilla, the median nearly under the point of attachment for the pectoral fin, the foremost on the projecting point formed by the clavicles.

There are often also small scattered melanophores. Ventral pigment is generally seen as a faint internal spot, most frequently a little behind the middle of the anal fin, e. g. level with the fifth ray from behind. There are as a rule small melanophores along the rays of the pectoral. On the head, there is a large melanophore at the posterior border of the operculum; under the angle of the lower jaw there is a prominent melanophore in connection with indications of a photophore (Brr); at the points of the snout and lower jaw and at the point of the hyoid arch also melanophores. Of photophores, we may at this stage find, besides the commencement of Brr, at times an indication of the uppermost *Op*.

As particularly characteristic for this species may be noted the præanal melanophores, and those of the head.

9 mm. (10.5). At this stage, the distribution of pigment is the same as in the foregoing; the eye is more oval, and the taper larger; remains of the larval marginal fin-fold far more pronounced. The upturned portion of the notochord distinct. Ventral fin only indicated; of photophores, only an indication of Brr.

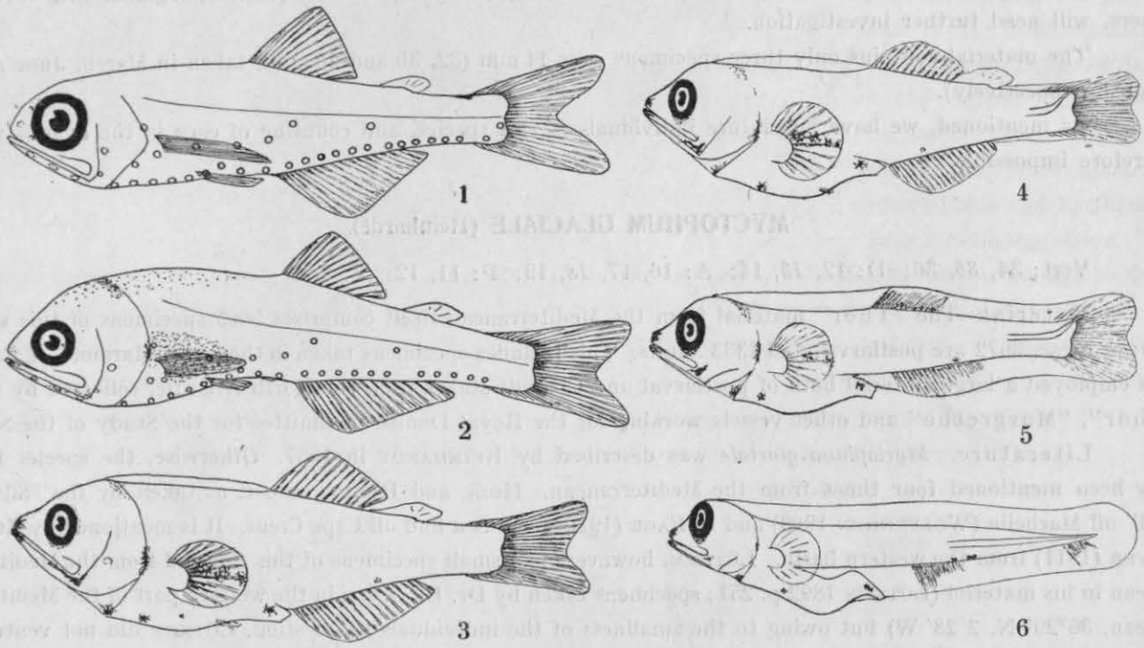

Fig. 11. *Myctophum glaciale* (Reinhardt). 1: ad. ♂; 2: metamorphosis stage 11.5 mm; 3: 11 mm; 4: 9 mm; 5: 7 mm; 6: 5 mm.

7 mm. (8). Distribution of pigment the same. Larval marginal fin-fold almost intact. Anus situate a good way in front of the fore margin of anal fin, (at a length of abt. 8 mm the anus is seen to be shifted farther back; at 9 mm, it is almost in the same position as in the older stages). Rays of the caudal developed; in the anal, the rays are formed in the anterior half, and can be counted there; in the dorsal, only the basal part is formed. Rays of the pectoral almost developed.

5 mm. The tail almost diphycercal, but an indication of the caudal fin discernible, as also incipient formation of the anal. Anus far in front of the anterior margin of anal fin; the intestine forms, as in the foregoing stage, a strong downward curve. Distribution of pigment almost as in the foregoing stages; there may, however, at this stage, (as in somewhat older stages) be some fairly sharp melanophores discernible ventrally.

The metamorphosis stage is of the usual characteristic appearance. Diffuse pigment on the head and down the back; also abdominally. Of postlarval pigment, remains of melanophores are generally visible at the posterior border of the operculum, under the angle of the lower jaw, on the points of snout and lower jaw, at the point of the clavicles and on the anal papilla. We have six specimens in the metamorphosis stage (10—11 mm)

with some photophores, more or fewer, and more or less postlarval and adult pigment. Four of these were taken with 2000 m. w. (Alboran Sea, in June), two with 1200 m. w. (Sea of Marmora, August).

Number of fin rays and vertebræ was counted in postlarval stages, and found to agree with what was noted in the case of the older individuals.

HOLT (1898) has, as mentioned, given a description of this postlarva. His description and figures (especially fig. 5 Pl. XLVI) show that the distribution of the melanophores in these Atlantic specimens is much the same as in those from the Mediterranean. I have also been able to satisfy myself as to this by examination of a large mass of material from the North Atlantic. From HOLT's and my own observations it would seem that in the Atlantic, metamorphosis takes place at a somewhat greater length than in the Mediterranean; the species appears altogether to be somewhat larger in the Atlantic than in the Mediterranean[1]). With regard to the catches reported by HOLT with FOWLER's vertical self-closing tow-net, in the Færoe Channel, the more reliable of these appear to confirm the idea that an ontogenetical vertical migration takes place. The numerous metamorphosis stages of this species which I have had from the Atlantic were also all taken with 1000 m. w. or over.

Adult characters.

1. No. of Vertebræ (Racial discussion). An examination of the Mediterranean material, and comparison with that from the Atlantic, led to the conclusion that the individuals from the Mediterranean must be regarded as belonging to a distinct race, which I propose to name *Myctophum glaciale* var. *Thori*, the species having been described by REINHARDT 1837(—38) from the Atlantic. The characters investigated were, no. of *AO*, no. of vertebræ[2]), and no. of rays in dorsal and anal fins. In the Atlantic material, samples were investigated from various localities (northern limit 61°11′ N, 11°54′ W; southern 40°34′ N, 48°53′ W); no marked difference is discernible between the different localities from which samples were examined, but further material would be required to determine whether the *Myctophum glaciale* from the North Atlantic all absolutely belong to one and the same race. It would be desirable, for instance, to investigate samples from Davis Strait for comparison with those from more southerly latitudes. For the present, however, we are only concerned to show that there does exist a distinct difference between the Atlantic race and the Mediterranean, and for this purpose, the present material will suffice.

I have selected two of the samples treated from the Atlantic for investigation of number of vertebræ. No. I in the table p. 34 is from west of Scotland ("Thor" St. 12, 28th May 1908, 57°03′ N, 11°20′ W), No. II from the Bay of Biscay ("Thor" St. 245, 17th Sept. 1910, 47°14′ N, 6°02′ W). From the Mediterranean also two samples were taken, one (No. III) from the Alboran Sea (this is, as will be seen from the following, the chief area of distribution of the species); this sample was taken at 36°02′ N, 4°24′ W ("Thor" St. 59); the second (No. IV) is a composite sample from stations east of the Strait of Messina, including the Ionian Sea, the Adriatic, and the Bay of Corinth. Unfortunately, *Myct. glaciale* is but sparsely represented in the material from the eastern Mediterranean, and it was therefore impossible to get a sufficiently large sample from any single station there.

The table clearly shows that there is a difference between the Mediterranean and Atlantic material in respect of the number of vertebræ, the most frequently occurring value for the former being 35 (15 + 20) that for the latter 36 (15 + 21). There does not appear to be any marked difference in this character between individuals from the two Atlantic localities, nor between those of the two separate samples from the Mediterranean. From the investigations of the "Thor" it was found that the spawning area in the Mediterranean lies chiefly in the Alboran Sea, and it is therefore possible that some of the individuals taken in the eastern Mediterranean originate from here, so that it would be impossible to assert the existence of any difference, if any does exist, on the basis of the material in question.

[1] cf. JOHS. SCHMIDT: *Gadiculus argenteus* and *Gadiculus Thori*. Mindeskrift for Japetus Steenstrup. Copenhagen 1913.

[2] By this is understood the total number of præcaudal and caudal vertebræ. I found as a rule 15 of the former, but as the transition from these to the caudal may be doubtful, I have throughout reckoned with the total number.

No. of vert.	Atlantic		Mediterranean		Marmora
	I	II	III	IV	V
37	2				
36	16	16	1	3	1
35	7	9	20	20	22
34	..	..	4	2	26
33	..	..	..	..	1
n	25	25	25	25	
M.....	35.800	35.640	34.880	35.040	
σ	± 0.600	± 0.507	± 0.475	± 0.454	
Fl.	± 0.405	± 0.342	± 0.320	± 0.306	
n	50		50		50
M.....	35.720		34.960		34.460
σ	± 0.546		± 0.470		± 0.582
Fl.	± 0.260		± 0.224		± 0.280

No. of *AO* sin.	Atlantic	Mediterranean	Marmora
14	10	1	
13	146	154	23
12	44	914	73
11	..	85	14
n	200	1154	110
M.....	12.830	12.062	12.082
σ	± 0.496	± 0.455	± 0.576
Fl.	± 0.118	± 0.045	± 0.185

No. of rays in *D*	Atlantic	Mediterranean	Marmora
15	1		
14	19	15	6
13	29	34	41
12	1	1	3
n	50	50	50
M.....	13.400	13.280	13.060
σ	± 0.575	± 0.499	± 0.424
Fl.	± 0.275	± 0.240	± 0.200

No. of rays in *A*	Atlantic	Mediterranean	Marmora
19	13	5	3
18	32	28	20
17	5	16	26
16	..	1	1
n	50	50	50
M.....	18.160	17.740	17.500
σ	± 0.584	± 0.672	± 0.416
Fl.	± 0.280	± 0.320	± 0.200

The second character examined was the number of maculæ anales. In respect of this character, 1154 specimens were dealt with from the Mediterranean, and 200 from the Atlantic. The Mediterranean material embraces nearly all the specimens taken in the Mediterranean itself, that from the Atlantic consists mainly of specimens taken in the Bay of Biscay. In the material from east of the Strait of Messina, the figures for the character in question were as follows: Six specimens had 13 maculæ anales sin., seventeen had 12 and one had 11. This material, however, is, as already mentioned, too small to serve as basis for distinction between individuals from the western and eastern Mediterranean, and I have therefore included these counts in the 1154 from the Mediterranean as a whole.

As will be seen from the table, this character exhibits quite as pronounced a difference between the Atlantic race and the Mediterranean as does the number of vertebræ; these photophores, like the vertebræ, are fewer in the Mediterranean form than in the Atlantic. The most frequently occurring value for *AO* in the Mediterranean is 6 + 6; in the Atlantic 6 + 7.

For investigation of the last two characters, the number of rays in anal and dorsal fins, a sample of 50 specimens was taken from the Atlantic material ("Margrethe" St. 1007, 4th August 1913, 49°46′ N, 30°01′ W) and 50 specimens from the Mediterranean ("Thor" St. 106, 36°33′ N, 2°00′ W). We find here much the same result as before, but as these two characters are, in certain fish, naturally dependent upon for instance the number of vertebræ[1]), I will not go further into this part of the question at present.

The Mediterranean fish, again, have 11—12 rays in the pectoral, whereas in my countings of Atlantic specimens, the figure 13 not infrequently occurs. Also with regard to size, there seems to be a certain difference, the Atlantic fish being on the whole somewhat larger. This I have already referred to when dealing with the post-larval characters, and will merely add, that while I have no fish from the Mediterranean over 47 mm (excl. caudal), the present Atlantic material contains still larger specimens, and there are on record elsewhere individuals of over 80 mm (these, however, reckoned with caudal included).

[1] See Johs. Schmidt: *Zoarces viviparus* L. and the local races of same (Comptes-rendus du Laboratoire de Carlsberg, Vol. 13, p. 290—291. Copenhagen 1917).

Between Gibraltar and the Bay of Biscay, the "Thor" took only four adult specimens of this species (postlarval stages were found in the Bay of Cadiz), and they must probably be reckoned as belonging to the Mediterranean race. The most northerly station at which this species was taken off the coast of Portugal is St. 71, (39°35′ N, 9°45′ W) and it would thus seem that there may possibly be a zone where *Myctophum glaciale* is of rare occurrence, between the Mediterranean race and Atlantic race, which latter is numerous in the Bay of Biscay. This, by the way, is now known to be the case with several species of fish. The Atlantic race hardly penetrates south of abt. 40° N (eastern Atlantic).

The numbers of vertebræ and *AO* in the four specimens mentioned were as follows:

1.	36°16′ N,	6°52′ W	Vert. 34	*AO* 6 + 5
2.	36°28′ N,	8°22′ W	— 35	— 6 + 6
3.	39°35′ N,	9°45′ W	— 35	— 6 + 6
4.	—	—	— 36	— 5 + 7.

No mention has been made in the foregoing of the remarkable isolated stock of *M. glaciale* found by the "Thor" in the Sea of Marmora. This form differs in several respects from the Mediterranean race, and I have therefore comsidered it best to keep it altogether apart, both in the racial discussion, and in dealing with the biological features. It is, however, so nearly allied to the Mediterranean form proper that I have not felt justified in establishing it as a distinct race, as, although a distinct difference between the Marmora fish and the Mediterranean is apparent in the number of vertebræ (34.460 as against 34.960, see table above), in the second important character, (*AO*) the two entirely coincide (12.082—12.062). The Marmora form is on the whole smaller than the Mediterranean. One other point should also be noted here. In the Atlantic and Mediterranean fish, I very rarely met with any abnormity in the structure of the spinal column; in the material from the Sea of Marmora, however, there were frequent instances of this. Abnormally short vertebræ may occur among the normal ones, or the spinal column may be curved sideways in one or two places, or upward and down.

2. Number of Photophores etc. Lütken and Brauer have pointed out that in the *Scopelids*, it is generally only the maculæ anales which vary in number, variations in the number (and position) of the other photophores within one and the same species being of very rare occurrence, and of no particular interest. I can myself, after going through the present large material from the Mediterranean, and a similar batch from the Atlantic, entirely concur in this.

Among the many specimens of *Myctophum glaciale* which I have examined, I met with one or two instances of variation in numerical values apart from the maculæ anales; in one specimen, for instance, I found 2 Pol, placed serially like the corresponding organs in *Lampanyctus elongatus*. While the maculæ anales, as will be seen later on, vary greatly in number, they are rarely seen to vary in respect of position; I have however, encountered two cases where they formed an unbroken series (of 12 and 13 organs respectively), but Pol was not lacking, and the position of this organ thus showed where the division of the unbroken series into two columns should be supposed to be. (cf. Brauer's theory that Pol should be regarded as belonging originally to the ventral series of photophores; (Brauer 1906—08, p. 1575--8)).

I will now proceed, as with the remaining species, first to note the frequency of the different combinations in which the maculæ anales anteriores and posteriores occur, then the frequency of maculæ anales anteriores and posteriores separately. By this means we shall readily obtain a view of the numbers and combinations in which *AO* can occur in this species. With regard to this character also, the stock in the sea of Marmora does not quite coincide with the typical Mediterranean race. As will be seen from the percentages, the figures 13 and 11 are more common in the Marmora than in the Mediterranean; this is not apparent in the case of the mean values, which is the same for the Marmora (12.082) as for the Mediterranean (12.062).

I may here remark, that though I myself have not found 6 + 5 represented in the North Atlantic, both Collet (1903) and Grieg (1911) have found this figure, (each records one such specimen). On the other hand,

7 + 7 is only very rarely found in the Mediterranean, whereas this figure, and also 5 + 8 and 6 + 8, which are not found at all in the Mediterranean, have been met with in several specimens from the Atlantic.

As mentioned above, the number of maculæ anales is not always the same on the right side as on the left. On going through the material of *Myctophum glaciale*, however, it was found that none of the combinations was more frequent on one side than on the other. I have nevertheless, in all species, consistently taken the photophores on the left side only, in noting the figures for *AO*.

Total *AO*	11		12			13		14
AO ant. + *AO* post.	5 + 6	6 + 5	5 + 7	6 + 6	7 + 5	6 + 7	7 + 6	7 + 7
Mediterranean	55	30	145	762	7	94	60	1
Percentage	4.76	2.60	12.57	66.03	0.61	8.14	5.20	0.09
Sea of Marmora	9	5	13	54	6	8	15	
Percentage	8.18	4.55	11.82	49.09	5.45	7.27	13.64	0.00

Maculæ anales	ant. or post.	5	6	7
Mediterranean	anteriores	200	886	68
	posteriores	37	877	240
Sea of Marmora	anteriores	22	67	21
	posteriores	11	78	21

There are some instances recorded in the literature of specimens found with a difference between the number on the right side and that on the left. This gave me the impression that the fact in itself must be a phenomenon of rare occurrence, and I was therefore surprised to find that in some species, such difference was discernible in up to half the total number of specimens examined. The point is not one of great importance as regards racial or specific distinction, and I will merely touch on it briefly in connection with the present species, *M. glaciale*, partly because it affords further occasion to note the difference between the Atlantic, the Mediterranean, and the Marmora forms, and partly also because it has been found that there are certain rules governing the discrepancy between the numbers of *AO* on the two sides.

Out of 1154 specimens from the Mediterranean, 18.1 % exhibited a difference between right side and left; while out of 110 from the Sea of Marmora, 31.4 % and out of abt. 200 from the Atlantic 14.5 % were found to differ in this respect. Here again we notice that the Marmora fish appear to diverge very markedly from the normal. On examining the variation in the number of maculæ anales on right and left sides, 36 different combinations were found for the Mediterranean, the Marmora, and the Atlantic; e. g. 6 + 6 on left side and 5 + 7 on the right; 6 + 7 and 6 + 6; 5 + 7 and 6 + 7.

I have selected these three examples in particular, as they serve to illustrate the three rules which apply, with but few exceptions, for the position of the photophores opposite one another on the two sides of the fish, not only in this species, but also in all the *Scopelids* which I have had an opportunity of investigating with regard to this feature. Normally, the number of photophores on right and left sides is the same, and the organs are situate directly opposite one another. Where the numbers differ, however, the following cases may occur:

a. *AO* anteriores in unequal, *AO* posteriores in equal numbers on left and right sides (e. g. 5 + 7 and 6 + 7): *AO* anteriores nos. 2 and 3 (counting from the front) are set more closely together than normal on the side where the higher figure occurs, and nos. 1 and 2 of the other side are then as a rule set a little farther apart.

b. *AO* anteriores in equal, *AO* posteriores in unequal numbers on left and right sides (e. g. 6 + 7 and 6 + 6): one organ (often smaller) is placed at the rear end of the series of *AO* post. on the side where the higher figure occurs, with no corresponding organ opposite on the other side.

c. *AO* anteriores and posteriores differing in number on the two sides (e. g. 6 + 6 and 5 + 7): the hindmost of the anteriores on the one side and the foremost of the posteriores on the other have no corresponding organ; the two Pol are set obliquely opposite one another, being situate at a certain definite distance from the hindmost anteriores.

3. Infra- and supra-caudal luminous plates (the secondary sexual characters). In all the larger individuals, I have found luminous plates either infra- or supracaudally, or both; LÜTKEN, however, mentions nothing as to this, while BRAUER (1906) states that in three specimens of 4.6—4.7 cm examined by himself, no sign of these luminous plates was discernible. It would seem most probable that the three specimens in question

were so damaged that the secondary sexual characters had become partially obliterated, as I have found this feature in the Atlantic form exactly as in the Mediterranean.

In *Myctophum glaciale*, the male luminous plate is seen to be situate in a pit with raised posterior margin, the anterior margin passing over evenly into the surface of the surrounding scales; the organ is situate slightly in front of the first rays of the caudal fin, and is, with the anterior portion included, rather egg-shaped. A faint incipient formation can be found in specimens of 23 mm (excl. caudal); in all investigated specimens of 30 mm and over, the organ was found to be well developed. There is thus no question here of a variable character, since it is always found in specimens of a certain size. In some individuals, the organ is larger than in others of the same length, but on the whole, the size of the organ seems, as one would naturally expect, to follow the length of the individual. With this species, a certain amount of spawning evidently takes place throughout the whole of the year, and I have therefore found it impossible to determine with certainty whether there is any marked increase in the size of the organ when the fish are nearing their spawning time. This hardly seems to be the case, however; if the fish die after spawning, as much would seem to suggest they do, it would then be reasonable to suppose that the organ attains its maximal size by gradual increment, the development then culminating naturally at spawning time.

The female luminous plate in *M. glaciale* is a simple circular spot infracaudally, situated a little in front of the commencement of the caudal rays, and a little behind the last pair of maculæ anales posteriores. Faint indications of this plate may at times be discernible in specimens of 24 mm, but not until a size of 30 mm and over is it always found. There may at times be two spots; the foremost is then smaller than the other, and must, from the position of the two, be the additional one; in one or two cases, a partial fusion of the two takes place. I have found two infracaudal luminous plates in 17 specimens (out of 202 ♀♀) in sizes from 29 to 43 mm, which shows that it is not a normal character developed gradually by all individuals. Of the 17 cases in question, 8 were from the Sea of Marmora (out of 40 ♀♀) and only 9 from the Mediterranean proper (out of 162 ♀♀).

As mentioned above, I have only in a few cases found both infra- and supracaudal luminous plates. Among 423 specimens in which the secondary sexual characters were developed, and which were carefully examined for this feature, there were 10 (lengths between 31 and 41 mm) with organs both infra- and supracaudally, but in all cases one or the other was more strongly developed than its fellow. Here again the number of cases was proportionately greatest in the Marmora (4 out of 83), and comparatively small in the Mediterranean (6 out of 340).

Length in mm excl. caudal	Approximate length of luminous plates in mm in ♂♂	and ♀♀
25	0.2	0.2
30	0.5	0.3
35	1.0	0.5
40	1.4	0.7
45	1.5	?

In the species of the *Myctophum* group, and in two *Diaphus* species, these infra- and supracaudal luminous plates present a character which enables us easily to sort out the material into ♂♂ and ♀♀. Possibly there may, among some hundreds, be found one or two specimens which by anatomical investigation would be placed among the males, while the infracaudal plate marked them as female — I have met with a single instance of this nature — but such cases are so rare that they have no effect upon the total picture obtained by sorting according to this secondary sexual character. The graph below (fig. 12) shows the state of things as it appears for *Myctophum glaciale* (specimens with both infra- and supracaudal luminous plates of course not included here). A great number were, besides being examined for infra- and supracaudal plates, also dissected for determination of sex. Each female is indicated by a circle to the left of the figure denoting length of specimen, each male by a similar sign on the right, and between the two groups are figures showing the number of specimens from 22 mm upwards which had as yet no indication of secondary sexual characters (even when examined by lens or under microscope). There are 162 ♀♀ and 178 ♂♂, i. e. about equal numbers of both sexes, but this need not, of course, represent the actual normal proportion; if for instance the females died off sooner after spawning than the males, the proportion would probably be very different.

It would also appear, from the graph, as if the females in *Myctophum glaciale* were smaller on the whole

than the males, and that certain individuals among the latter reach a greater length. It will be noticed that the largest female measures 43 mm, whereas the largest male is 47 (excl. caudal; the lengths inclusive abt. 50 and 55 mm). From the Atlantic I have specimens considerably larger, and there are records in the literature of sizes far beyond this (COLLET, for instance, notes a specimen of 85 mm incl. caudal).

From the Sea of Marmora, we have 40 ♀♀ (from 24—37 mm) and 43 ♂♂ (from 24—39 mm) these are not included in the graph, as they are smaller on the whole than the Mediterranean specimens, and their inclusion here would render the actual proportions less clearly apparent.

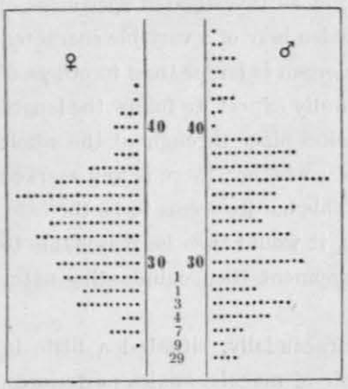

Fig. 12. Graph showing length and number of specimens of ♀♀ and ♂♂ (see text).

I append some figures showing the approximate length of the caudal fin (it varies somewhat) at the different lengths of the fish reckoned without the caudal:

In specimens from 10—20 mm, *C* grows from 2.25 to 4 mm
— — 20—30 - — — 4 - 5 -
— — 30—46 - — — 5 - 8 -

Distribution. *Myctophum glaciale* has, as mentioned above, only recently been determined with certainty as belonging to the fauna of the Mediterranean. Its distribution covers a wide area; it has been taken in several parts of the North Atlantic from the Davis Strait and the Norwegian Sea down to abt. 35° N (western Atlantic).

Reference has been made in the foregoing to the few finds off the coast of Portugal and in the Bay of Cadiz. In the Mediterranean, the species belongs to the western portion, as seen from the chart; east of abt. 8° E, and in the northern part of the Balearic Sea it is found but sparsely. Owing to the peculiar current conditions in the Mediterranean, it seems likely that the specimens found in the eastern Mediterranean may have originated from the principal area of distribution of the species. The length of the specimens taken east of the Strait of Messina up in the Bay of Corinth appears as follows:

Length in mm:	10—15	15—20	20—25	25—30	30—35	35—40
No. from summer cruise ...	3	8	1	»	1	1
No. from winter cruise	»	1	11	2	»	1

It will, however, be noticed that the larger specimens are generally taken in winter, the smaller ones in summer. This, together with the fact that they are taken right up in the Bay of Corinth, might seem to suggest that the species really spawned here, and has a more sharply defined spawning time here than in the main area. If so, spawning would then take place in early spring, and it would then be easy to understand why no postlarval stages were taken by the "Thor". The present material, however, must be regarded as insufficient for deciding the question.

Finally, the "Thor" found in the Sea of Marmora a rich stock of this species, which here forms a small isolated tribe. The connection between this and the Mediterranean race, which must be regarded as the mother stock, seems difficult to explain, as the species was not met with at all in the Ægean. As two other species also occurring in the Marmora (*M. Benoiti* and *L. crocodilus*) are found in the Ægean, we must presume that *M. glaciale* has passed through the latter sea into the Marmora, finding there, in the water layers derived from the Mediterranean, suitable conditions for propagation.

It is interesting to note the frequency of occurrence in the various parts of the area of distribution. The main region lies particularly in the Alboran Sea (and along the coast of Algeria); the frequency here will be apparent from the figures for number of specimens (adults and postlarvæ) taken at some of the richer stations.

St. 59	(Alboran Sea)	206 adults
-107	—	118 —
-108	—	151 —
-228	—	118 —
-175	(Sea of Marmora)	113 —
- 57	(Alboran Sea)	914 postlarvæ
-108	—	1101 —
- 47	(Coast of Algeria)	209 —

Finally, it may be added that in the Alboran Sea, 898 adults were taken, in the remaining part of the main area only 275 adults. The stock in the Marmora, however, seems also to be fairly rich; we have here, from St. 175, a catch of 137 specimens (adults and postlarvæ).

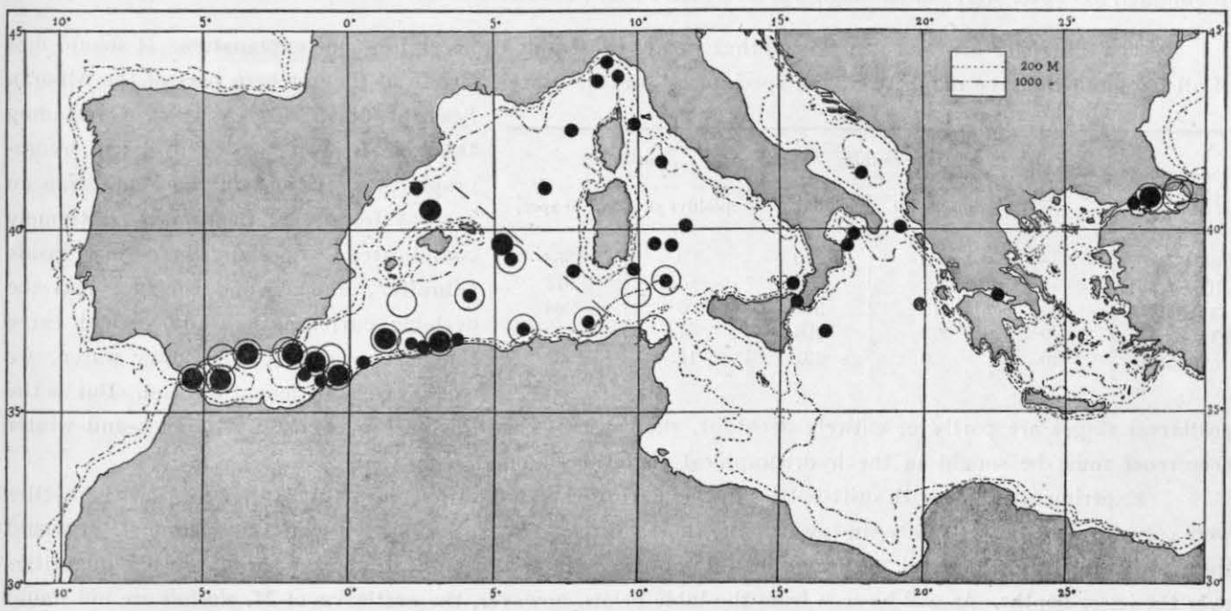

Fig. 13. Distribution of *Myctophum glaciale* (Reinhardt) according to the investigations of the "Thor". ● < 20 adult stages; ● > 20 adult stages; ○ postlarval stages (see text).

The frequency within the area of distribution will be even more clearly apparent from the table here, where the Mediterranean is divided into a western portion (including the main area of distribution of the species) an eastern part, and the Sea of Marmora; in the chart of the area of distribution, the boundary between the main area and the eastern portion is indicated by a dotted line[1]),

As the temperature and salinity in the Mediterranean increase towards the east, it is possibly these factors which determine the distribution of the species here.

As with the *Scopelids* generally, so also with

			Total no. of spec.	No. of spec. pr. hour
Winter cruise	Main area	ad.	371	37
		juv.	1867	170
	Eastern portion	ad.	16	2
		juv.	0	0
Summer cruise	Main area	ad.	777	48
		juv.	1771	134
	Eastern portion	ad.	46	5
		juv.	6	3
	Sea of Marmora	ad.	114	57
		juv.	28	14

[1] It may here be noted, partly as an indication of how well the "Thor" actually fished, that in June and end Aug. to beginning of Sept. much the same parts of *M. glaciale*'s main area were visited; in June, 47.58 adults pr. hour were taken here, in Aug.-Sept. nearly the same number, 48.15 adults per hour.

Myctophum glaciale, we find that the fish are taken over great depths; this applies particularly to the adults, as will be seen from the table below. The postlarvæ appear to be less markedly restricted to the greater depths, but as they are denatant, this is not surprising.

A point not apparent from the table is the fact that altogether only a very few specimens were taken inside the 700 metre limit; outside this, especially towards the 1000 m line, the numbers increase. Of the adults taken inside the 700 metre limit (33 in all) 22 (large specimens) are from St. 57 in the Bay of Aleusia (36°40′ N, 3°30′ W); the finding of these in shallow water may possibly be due to special conditions of current.

As regards the distribution of the postlarval stages in connection with the depth at the different localities, the following should be noted. A comparison of the number of postlarvæ found inside the 700 metre limit in winter and in summer, shows, that

in winter, 1276 spec. were taken inside the 700 metre limit, (out of a total 1867 spec. from the winter cruise);
in summer, 65 spec. were taken inside the 700 metre limit, (out of a total 1805 spec. from the summer cruise).

The difference here is so surprising that we are constrained to seek for some explanation. It should first of all be noted that the majority of the specimens taken in winter were from the northern part of the Alboran Sea, (St. 55, 57 and 58 — i. e. including the St. 57 just mentioned). The hydrographical conditions in the Mediterranean are, as frequently mentioned, extremely complicated, especially here just inside Gibraltar, and beyond the fact that the cyclonic currents in winter would carry the postlarvæ in to shallower water, we can say very little on this head. But as the postlarval stages are partly or entirely denatant, the cause of this difference between the summer and winter occurrence must be sought in the hydrographical conditions alone.

Soundings in metres	Total no. of stations	adults		postlarvæ	
		positive st.	no. of spec.	positive st.	no. of spec.
0—100 ..	18	0	0	3	363
100—500 ..	19	2	27	4	975
500—1000 .	25	13	371	6	266
1000—2000 .	29	13	496	4	130
>2000 .	40	20	431	14	1938

Experiments made with drift-bottles in this part of the Mediterranean in 1912[1]) showed, that the bottles were carried, often quite rapidly, in towards the shores of the Alboran Sea both in winter and summer. It would therefore seem strange that the postlarvæ should not also be met with both summer and winter in like quantities over the lesser depths. As will be seen from the table below, however, the postlarvæ of *M. glaciale* are not found all the year round in the same water layers, their vertical distribution being in fact such that great quantities of them are found during winter in the very uppermost layers, (the movement of which, of course, determines the course of drift-bottles set out). In summer, on the other hand, few or none are to be found here, the fish being then farther down in the water. This, then, serves in some degree to explain why it is that two-thirds of the postlarvæ are found during winter in the shallow water which they seem to avoid in summer.

The table does not include specimens taken with over 300 m. w., partly because they were few in number (25 on the winter cruise, 142 on the summer cruise; these taken, perhaps, partly while hauling up the net) partly also because only a few hauls were made during the winter at greater depths (abt. 2000 m. w.).

Metres of wire out	Winter			Summer		
	4,5—7 mm	7—10 mm	>10 mm	4,5—7 mm	7—10 mm	>10 mm
25	412	385	..	5		
65	70	72	2	96	109	2
300	236	250	3	643	769	18

It is not, however, only the postlarval stages which live at different depths in summer and in winter; the same applies also to the adults, but as these move of their own volition, and are not denatant like the postlarvæ, we do not find them — or find them only exceptionally — in shallow water.

[1] See JOHS. SCHMIDT: Experiments with drift-bottles (1st Report) in vol. III of this Report. Copenhagen 1913.

This leads us to consideration of the vertical distribution, and the conditions which stand in connection therewith.

The accompanying table shows, that the adults behave to a certain extent like the postlarvæ, keeping to the uppermost water layers in winter, and in summer — especially June and July — moving at depths where they would be taken with 300 m. w. but also higher up and lower down.

Metres of wire out	Winter		Summer		
	No. of sp.	No. pr. hour	No. of sp. June—July	No. of sp. Aug.—Sept.	No. pr. hour
25	154	103	6	56	21
65	73	24	56	14	19
300	30	12	302	149	56
1000—2500	49	7	112	157	26

That the specimens taken with 1000—2000 m. w. can hardly all be taken during hauling in, but are doubtless in part actually caught at depths beyond the range of 300 m. w., will be seen from the catches made at stations where few or none were taken at the lesser depths. Some other stations also show a comparatively rich yield at the greater depths, but as quite as many or even more specimens were taken at lesser depths, the catch made with 1000—2000 m. w. might still in these cases be explained as possibly due to inclusion of individuals taken while hauling in.

Of these three stations, No. 107 was a day station, 206 night, while 209 was mainly a day station. Where no figure is noted in the table, this indicates that no hauls were made at the depth in question.

Metres of wire out	St. 107	St. 206	St. 209
25	..	0	0
65	1		
100	..	..	0
150	..	..	0
300	0	8	0
1000	..	0	29
2000	37	15	26

Why this species (and others) should move at different depths in summer and winter, cannot be decided from what we know at present (see Introduction p. 14); possibly this feature in the biology of the species may be explained by an investigation of conditions in the Atlantic, where the hydrographical conditions are less complicated. Unless the cause is an indirect one (e. g. movement of the organisms on which the species feeds) it may possibly lie, for instance, in the alteration of light conditions from summer to winter. Possibly several factors combine.

At the greater depths, the specimens were taken for the most part, though by no means always, during the day. This fact has already been mentioned above. On comparing the present material of adults (specimens from the Marmora not included) we find, that

of 1187 specimens taken in 60 night hauls, 186 were taken with over 500 m. w.,
of 124 specimens taken in 13 day hauls, 122 were taken with over 500 m. w.

Nearly all the specimens from the day hauls, then, are from depths worked with over 500 m. w.; this is not the case with the night hauls. Further examination of the distribution per positive hour summer and winter shows the following result:

Spec. taken with over 500 m w.	Day hauls				Night hauls			
	No. of hauls	pos. hauls	No. of spec.	pr. hour	No. of hauls	pos. hauls	No. of spec.	pr. hour
Winter	7	6	25	4	7	3	40	16
Summer	7	5	97	24	17	11	146	19

With less than 500 m. w. 6 day hauls were made in the winter, and 6 in summer; as in the foregoing, only those hauls are included which were made at stations where the species was taken at all. One individual was taken in winter (with 300 m. w.) and one in summer (with 65 m. w.), (20 mm and 12 mm). As 23.5 % (308 out of 1311 spec.) were taken with over 500 m. w. we must suppose that a part of those taken actually belong to these depths, and were not merely taken while hauling in.

We see from the foregoing, that 12 day hauls with less than 500 m. w. yielded 2 specimens; 13 day hauls

with more than 500 m. w. gave 122; that the greater part of the material from the night hauls was taken in the upper water layers; that more day hauls than night hauls with over 500 m. w. gave positive result (the night hauls, however, yielding the greater number of specimens); and that in winter, a greater number of specimens was taken per hour at great depths than during the day (according to the theory of vertical migration, we should expect to find the reverse).

This fact that so few specimens per hour were taken in winter at greater depths, might seem to suggest that *M. glaciale* in winter, when it is found in the upper water layers, only extends its day-to-night migrations so far that the bulk of the fish do not penetrate below the region fished with 500 m. w. or less, while in summer, when it keeps deeper down altogether, it is taken in greater quantities deeper down also during the day. If this be so, then the vertical day-to-night migration will in winter amount to abt. 500 metres at the very outside.

I myself do not consider the greater vertical day-to-night migrations of *M. glaciale* as proved with absolute certainty, but could imagine, for instance, that difference in day and night catch might be due to the fish being better able to elude the nets during the day. My reason for taking this view lies in the results of investigations made with the object of ascertaining whether possibly the different size groups might be found to keep at different levels (ontogenetic migration). I was here obliged to restrict myself to investigation of material from the summer cruise, (and naturally only from the principal area of occurrence of the species), as the material from the winter cruise had to be discarded on account of its insufficient quantity, and the too small number, for instance, of deep hauls.

For the purposes of this investigation, I selected two groups, one from 10—19 mm, the other from 30—39 mm (both figures in each case inclusive) as these two size-groups include on the one hand the smallest adult stages (adolescent stages) and on the other, the mature individuals. The result will be seen from the following table.

Metres of wire out	10—19 mm			30—39 mm		
	No. of spec.	No. pr. hour	%	No. of spec.	No. pr. hour	%
25.....	23	15	4.2	12	8	14.3
65.....	30	15	5.5	13	7	15.5
300.....	302	55	55.0	53	10	63.1
1000—2000...	194	27	35.3	6	1	7.1

Out of 194 specimens taken with 1000—2000 m. w., 142 were less than 15 mm, i. e. at the stage immediately following metamorphosis, during which they are found at greater depths (see p. 18—21). From this it is plain that they are now about to move up towards the higher water layers. Furthermore, of these 194 specimens, 80 were taken in day hauls, and to great extent also at the above mentioned stations (107 and 209) which I cited as showing that the species was found at great depths. Of the 6 adults taken with 1000—2000 m. w., one was taken in a day haul.

A further contribution to elucidation of this question is afforded by the following table showing depths at which the largest postlarvæ (over 10 mm) were taken.

Length of wire in metres	No. of specimens	Percentage
25.....	0	0 %
65—100.....	6	9 %
300.....	21	31 %
over 300.....	40	60 %

To this may be added, that out of the entire material of postlarvæ, 167 specimens, or hardly 5 % of the total, were taken with over 300 m. w. We see then, that even these stages are already on their way down to the greater depths.

From all this it is evident, that *M. glaciale*, at the different stages of its life, lives to a certain extent in different levels, and the fact that we may during the day take at greater depths individuals naturally belonging there at the stage represented, can of course not warrant our drawing conclusions as to vertical day-to-night migrations of any great extent.

Of some interest in connection with the possible vertical day-to-night migrations of the postlarvæ is the following table. It may be added that at depths below that fished by 300 m. w., only few specimens (150 or so) were taken.

The table tells us but little beyond what we have already seen, that the postlarvæ keep in deeper water during summer than in winter; with regard to vertical day-to-night migrations, it seems to suggest that such do not take place; at any rate the fact is not distinctly discernible from the present material.

Length of wire in metres	Day hauls				Night hauls			
	Winter		Summer		Winter		Summer	
	Total	pr. hour	Total	pr. hour	Total	pr. hour	Total	pr. hour
25.....	130	65	0	0	667	333	4	8
65.....	100	40	110	63	42	17	94	54
300.....	243	81	40	6	246	82	1387	213

Propagation. It is impossible to draw any conclusions from the present material as to possible seasonal or spawning migrations in *M. glaciale* beyond what has been mentioned in the foregoing (p. 14 and p. 40—41).

As will be seen from the accompanying graph, the winter hauls exhibit no marked predominance of any size-group, most sizes being evenly represented. It is otherwise, however, with the graph for the summer yield; here we find two distinct groups, lying in the region of abt. 14 mm and abt. 34 mm.

An explanation of this may be gained by considering the catches of postlarval stages. I have here included only those postlarvæ which were taken in the main area; as already mentioned, these comprise almost the whole of the material. The Sea of Marmora is here, as usual, not touched. In February, mid-June and early September the "Thor" was working at about the same places within the principal area of distribution of the species. The catches for these three months are shown below:

Month	Total	pr. pos. hour
February.....	1867	170
June.....	1627	167
September....	144	41

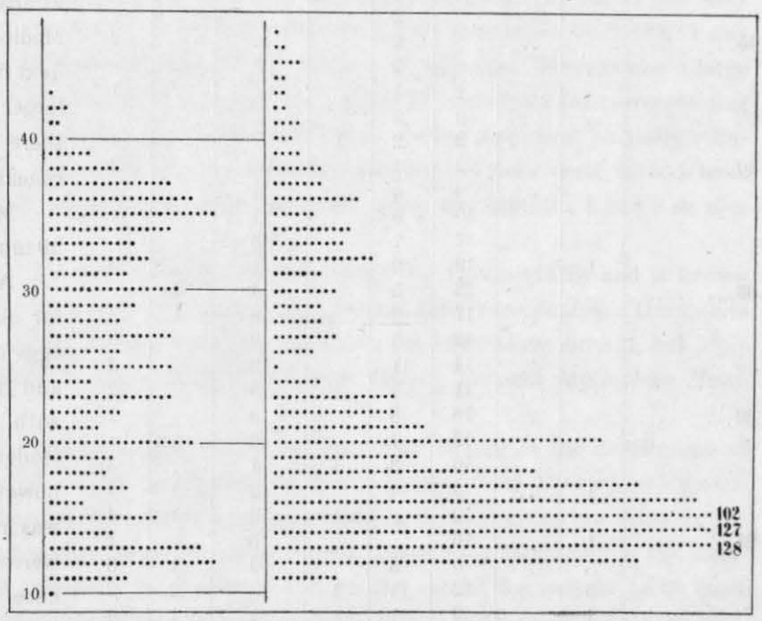

Fig. 14. *Myctophum glaciale.* Length in mm of specimens from the winter cruise (first column) and the summer cruise (second column).

From this it is apparent that spawning must take place chiefly in winter and spring, but in all probability there is a certain amount of spawning all the year round. Unfortunately, we lack material both from early spring and from late autumn for discussion of this point. That the case should be as here suggested, is, however, further supported by the figures for yield of the smallest groups, as shown p. 44.

It will be seen that the proportion of individuals belonging to the smallest group decreases from February to September (and especially from June to September), while the proportion of specimens from the largest group increases[1]).

Supposing now that the postlarvæ are abt. 1—2 months old at time of metamorphosis (it doubtless varies somewhat, whether in February or August, according to temperature) we then arrive at much the same result

[1] I may here call to mind that the metamorphosis stages which were found in the principal area of distribution of the species were taken in June.

as shown by the graph. The table below, showing sizes of *M. glaciale* in the different months gives more detail than the graph. The great difference in quantity between the different months is of course more especially dependent on the places where the "Thor" fished at the time, but for the three months of February, June and September, the point is, as above mentioned, of but slight importance. We see that in February, there are about equal quantities of all sizes; in June, the youngest stages are especially numerous, and the oldest stages also richly represented; in September there are still many of the youngest, but few of the oldest stages (always exclusive of the Marmora, where other conditions evidently prevail).

Length in mm	February		June		September	
	No.	%	No.	%	No.	%
10—11	7	0.4	50	3.1	6	4.2
7— 9	949	50.8	859	52.8	96	66.6
<7	911	48.8	718	44.1	42	29.2

We must suppose, then, that *Myctophum glaciale* normally attains an age of one to one-and-a-half years (some possibly live longer) and that the individuals spawned, for instance, in February, (Group 0) will be ready to spawn the next year (Group I); after spawning, they probably die; at any rate, we know of no specimens from the Mediterranean which could belong to the group next following. From the Atlantic, as mentioned, larger individuals are known, but the race there is evidently larger than in the Mediterranean.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	June 1910	July 1910	Sea of Marmora	Aug. 1910	Sept. 1910
	..	..	..	..	1			
	..	..	..	2				
45	..	..	..	2	..	..	..	2
	..	..	..	2				
	..	..	1	1	..	..	..	1
	..	..	3	2				
	..	..	2	2	1	..	..	1
40	..	..	2	1	..	..	..	2
	..	..	6	4	..	1		
	..	..	10	6	..	1	..	1
	..	..	17	7	..	6		
	1	..	19	9	..	1	..	3
35	..	..	23	5	..	14	1	
	..	..	17	2	..	8	1	8
	..	..	12	5	..	9	..	5
	..	..	14	11	..	12	..	3
	..	..	11	4	1	8	..	2
30	..	..	18	8	..	8	..	1
	..	..	12	7	..	6		
	..	..	10	3	1	1	..	3
	1	..	16	4	..	2	1	4
	..	..	10	..	1	4	1	4
25	1	..	16	..	..	5	..	1
	..	..	6	3	..	4	1	3
	5	..	12	11	1	..	2	3
	1	..	9	11	1	1	1	4
	..	..	7	12	..	..	4	5
20	5	1	14	21	4	..	9	11
	..	..	9	11	1	1	..	8
	..	..	8	19	2	..	5	10
	..	..	11	27	3	2	7	13
	..	..	5	31	3	2	5	19
15	1	..	14	58	4	2	8	32
	..	..	9	52	1	5	27	47
	..	..	21	70	1	8	18	39
	..	..	23	33	..	2	9	8
	..	..	11	6	..	1	..	3
10	..	..	1	..	..	..	..	..

Maturity is attained at a length of abt. 30 mm (excl. caudal) or more.

A great number of specimens were examined for number of eggs in the ovaries, size of the eggs and of the ovary, etc. Both from February, and from June and September, we have females with large eggs in the ovaries, which would evidently soon ripe; in the material examined, however, the number of fish nearing maturity was relatively lowest in February. The ovaries were as a rule of the same length, if any difference, the left was longer, but the right was then generally a little broader. The largest ovaries were abt. 8.25 mm long and abt. 2.50 mm greatest breadth, the smallest (with eggs over 0.25 mm) were abt. 5.00 mm long and abt. 1.5 mm broad. The largest eggs measured were close on 0.50 mm in diameter; in all the specimens examined, the eggs were still opaque, not fully ripe. The greatest number of large eggs (over abt. 0.25 mm) occurred in the largest specimens, as will be seen from the figures p. 45.

The local form from the Sea of Marmora. The pecularities exhibited by this form in respect of photophores, number of vertebræ, etc. have been dealt with in the foregoing (p. 34—36). As regards biological conditions,

we can say but very little, as we have only one station (175) from which a large amount of material was obtained. The species was taken with from 35 to 1200 m. w., fairly evenly distributed throughout the different depths, but only a few (28) postlarval stages were found. The form appears to be somewhat smaller than that of the Mediterranean. And finally, it seems to divide more sharply than the Mediterranean form into two size groups (see table above for sizes in the different months).

Length of fish (excl. caudal)	No. of large eggs
32 mm	(124 + 123) = 247.
33 —	(126 + 162) = 288.
34 —	(97 + 94) = 191.
38 —	(204 + 206) = 410.
39 —	(159 + 176) = 335.
40 —	(232 + 235) = 467.

The species occurs in the Marmora mostly at depths where the temperature is comparatively low, and salinity high; i. e. in the Mediterranean water which penetrates through the Dardanelles into the Marmora[1]).

MYCTOPHUM BENOITI (Cocco).

Vert: 35, *36*; D:12, *13*, 14; A: *19*, *20*, 21; P: 14; V: 8.

Material. Of this species, we have from the Mediterranean 583 adult specimens; of these, 403 were taken by the "Thor" (398 in the Mediterranean proper, 5 in the Sea of Marmora); 174 were taken by the S/S "Pangan" in November—December 1911, and 6 at Messina in March 1911 by Capt. G. Hansen. There is also a large material of postlarval stages, but as I have not been able to separate the smaller of these from the corresponding stages of *M. Hygomi*, I cannot state the precise number of postlarvæ for this species, and must partially relinquish the further treatment of this material. After this and the following species have been dealt with, a brief survey of the total postlarval material of both will be given under one head. From the Atlantic, I had a smaller amount of material at my disposal.

Literature. The species has been described from the Mediterranean by Cocco (1838) and is known from here by several writers. I would here draw attention to the fact that Leydig (1881) has confused the species with others. Leydig's figure 38 (Plate VI) and fig. 39 (likewise Plate VI) show, not *Myctophum Benoiti*, but *Myctophum punctatum*; Fig. 57, on the other hand, (Pl. X) is really *Myctophum Benoiti*, and not *Myctophum Humboldti*, as stated. See also Brauer (1906).

Postlarval characters. In the postlarval stages, I have not been able to find in the distribution of the melanophores any such characters as would serve to distinguish this species sharply from *Myctophum Hygomi*; largely on account of the fact that the pigmentation seems to vary somewhat in these two species. Thus in the Alboran Sea and adjacent waters, the present species seems to exhibit more pigment than farther up in the Mediterranean; the melanophores on the caudal peduncle, for instance, and on the caudal fin, appear to be more highly developed in specimens from the former localities than in those from the waters farther east, while the Marmora form seems more to resemble that of the Alboran Sea in this respect.

The postlarvæ of this species are distinguished from those of *M. glaciale* chiefly in being of considerably slenderer build; in having only very faint melanophores on the head; and in the fact that the anus at all stages is situated just at the anterior margin of the anal fin. The largest postlarvæ are easily distinguishable from those of the species next following (*M. Hygomi*) in being considerably smaller, metamorphosis taking place at a length of 10—12.5 mm. in the present species, as against 13—14.5 in the next. Smaller stages are less easy to identify. This can, however, as a rule be done, with stages down to abt. 7 mm length, by means of measurements and comparison, as the fin rays, etc. in the present species are more strongly developed than in specimens of the same size belonging to *M. Hygomi*; the eye also, in these large stages, is hardly ever so narrow as in *M. Hygomi*. I have touched upon this difference in development etc. between the two species in dealing with the postlarval stages

[1] See J. N. Nielsen: Hydrography of the Mediterranean and Adjacent Waters, p. 115 et seq. in Vol. I of this Report, 1912.

of the latter. The number of fin rays in the two species is practically useless as a means of separating the postlarval stages.

The position of the melanophores etc. may be briefly dealt with.

10.5 mm (12.5 with caudal). This stage comes immediately before the metamorphosis. Pectoral large, but rays in process of prolongation; in the remaining fins, the rays are formed, but have not yet reached their full length. Incurvation of the caudal smaller than in the adult stages. Eye with distinct taper, but in process of rounding off. Remains of the larval marginal fin-fold (the dorsal sinus especially prominent). Præanal pigment on the anal papilla and farther forward; here, along the underside of the intestine, there may be up to 8—9 melanophores serially. On the head, there is often a very slight pigmentation at the posterior margin of the jaw; also

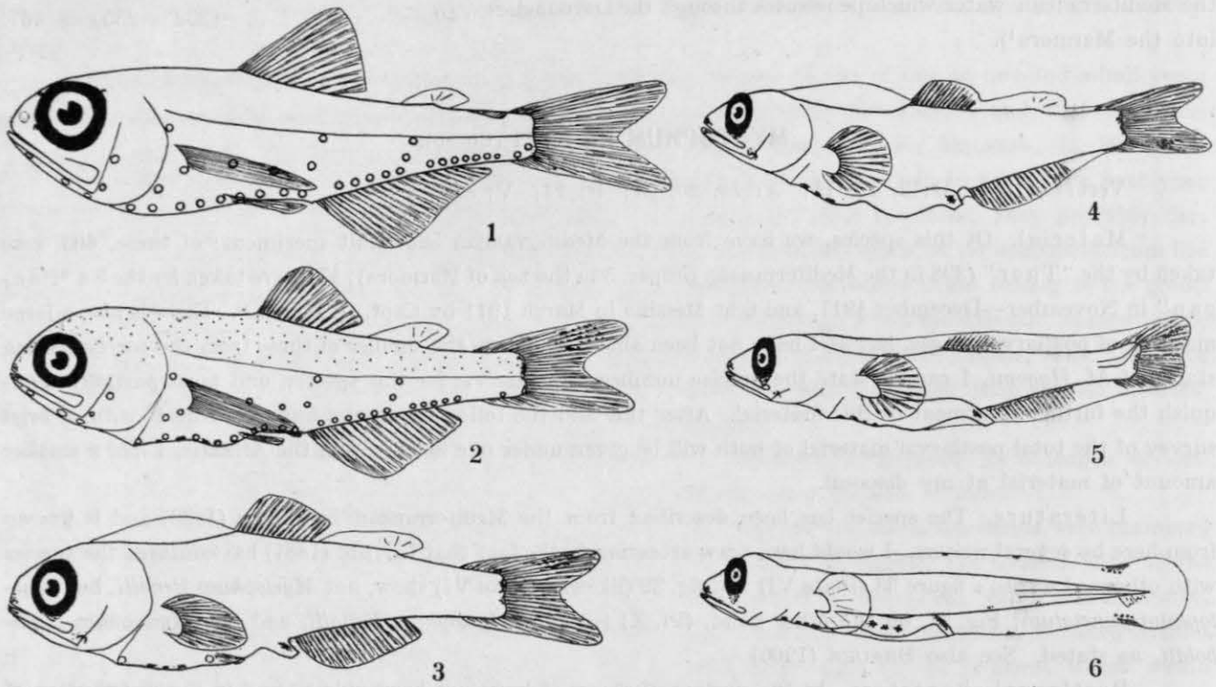

Fig. 15. *Myctophum Benoiti* (Cocco). 1: ad. ♂; 2: metamorphosis stage 11 mm; 3: 10.5 mm; 4: 8.5 mm; 5: 7 mm; 9: 5 mm.

on the snout. On the caudal fin, and at base of same, there is often some pigment, at times rather extensive. More rarely, ventral pigment may appear, as a couple of internal melanophores at base of anal fin; at times slight pigment on the points of the fin itself. Now and again I have observed a melanophore at the adipose fin. Of photophores, there is a Brr., and one or two *PO* may also be developed.

8.5 mm. (10.5). Pigmentation may be as in the foregoing. This stage is far more larval in appearance, but the rays of the anal are nevertheless formed, and in the dorsal also almost entirely so. The ventral hardly discernible. Of photophores only a Brr.

7 mm. (8.5). Pigmentation may appear almost as in the foregoing stages; the melanophores are, however, as usual in the younger stages, smaller and more sharply defined. Larval character still more pronounced than in the foregoing; both dorsal and anal are, however, indicated, at any rate in the basal parts. Upturned part of the notochord distinct.

5 mm. The stage here shown probably belongs to this species.

The metamorphosis stage is of the usual characteristic appearance. As regards postlarval pigment, remains may be seen of the præanal as well as of that on the caudal fin and at root of same. Photophores differ in number in the different individuals. It may be noted that as in other species, so also here the lateral and caudal

photophores are last formed (*Brr*, *PO* and *VO* first). Of the typical metamorphosis stages, we have 31 (abt. 10—12.5 mm). All were taken with 1200 m. w. or over (most with 2000 m. w.); the majority (30) were taken in summer. The number of fin rays agrees with that found in the adults.

EMERY (1883) has in his fig. 12—13 Pl. 28 shown two postlarvæ which may possibly be of this species; the smaller specimen (4 mm) is the more doubtful of the two. REGAN (1916) likewise shows (fig. 1 and 2 Pl. VI) two postlarval stages which are referred to this species; this does not, however, agree with the results of my observations. Postlarvæ entirely corresponding to those shown by REGAN are to be found in the material from the Bay of Cadiz; they are possibly those of *Lampanyctus gemmifer*.

Adult characters.

1. No. of vertebræ. This character has been investigated in 20 specimens from the Balearic Sea. Of these, 8 were from St. 47, and showed in 7 cases 36 vertebræ, while 1 had 35; the remainder of the 20 are from St. 45, and of these, 9 had 36, and 3 had 35 vertebræ. For the Balearic Sea, then, the most frequently occurring value is 36 (15 + 21). From the Atlantic, only 9 specimens were examined, of which 8 had 36 vertebræ and only 1 had 37.

2. No. of photophores etc. From the Mediterranean, 554 specimens were examined for number of photophores. The various combinations, and number of maculæ anales, will be seen from the following table.

Total no. of *AO*	11		12				13		
AO ant. + *AO* post.	5 + 6	6 + 5	4 + 8	5 + 7	6 + 6	7 + 5	6 + 7	7 + 6	5 + 8
No. of specimens	61	15	1	111	322	5	31	7	1
Percentage	11.01	2.71	0.18	20.04	58.12	0.90	5.59	1.27	0.18

Of these 554 specimens, 103, or 18.6 %, showed a difference between the right side and the left in no. of *AO*. The three rules laid down under *Myctophum glaciale* were likewise found to apply almost without exception to this species, as also for the remainder. The five individuals taken in the Sea of Marmora showed the following combinations, which do not seem to differ from what is otherwise met with in the Mediterranean: 3 had 6 + 6, 1 had 5 + 7 and 1 had 6 + 5.

Maculæ annales ant. or post.	4	5	6	7	8
anteriores	1	173	368	12	
posteriores	..	20	390	142	2

3. Infra- and supra-caudal luminous plates (the secondary sexual characters).

The total number of specimens exhibiting secondary sexual characters was 73; of these, 61 were males, and only 12 females. The reason of this marked difference in number between the two sexes is simply the fact that the secondary sexual character is visible in the males already at a length of 17—20 mm, whereas in the females, it does not appear until a length of 24—25 mm is reached, so that we naturally get a larger number of small males here.

The secondary sexual character in the male appears as an elongated white organ between the adipose fin and the caudal; it is somewhat broader at the back than in front, and seems, as in the other species, to originate by metamorphosis of the scales; the limits between these, however, are here as a rule altogether vague, whereas in other species they are very sharply defined (I have found them most distinct in *M. phengodes*). The organ is apparent in specimens about 20 mm as a stripe about 1 mm long, increasing in length and breadth, and growing more distinct, with the growth of the fish. In specimens of abt. 30 mm the organ is abt. 2.0 mm long, and in those of abt. 40 mm it measures abt. 3.5 mm; the largest such organ was found in a specimen of 47 mm and was 5.0 mm long. As will be seen, the secondary sexual character in this species differs considerably from that found in the species next following.

In the female, the secondary sexual character consists of 1—4 small roundish or oblong plates infra-caudally, in a series; as a rule, they are fused together and are situate opposite the interval between the last *AO* and *Prc*; at times, (where several are present) they may run up between the two rows of *AO* posteriores. The

first indication of the organ is observed at a length of 24—25 mm and is then only discernible as a minute speck; at abt. 30 mm, however, it may already have reached a length of abt. 1.3 mm. It seems also, as if others are added with increasing age, as most of the larger individuals have 2—4 plates, but we may also find large specimens having only a single oblong plate (a female of 44 mm, for instance, had a plate 2.4 mm long). The infracaudal plates rarely extend over more than abt. 2 mm.

The length of the caudal fin appears to increase roughly according to the following scale:

In specimens from 11—20 mm, C increases from abt. 2.5 to abt. 5 mm
— — 20—30 - — — 5 — 7 -
— — 30—42 - — — 7 — 9 -

Distribution. *Myctophum Benoiti* has, as mentioned above, long been well known from the western basin of the Mediterranean, as also from the Atlantic.

From the investigations of the "Thor" it is seen to be distributed throughout the greater part af the Mediterranean, and has also been taken right up in the Sea of Marmora (adult and postlarval stages, as with *M. glaciale* and *Lampanyctus crocodilus*). Details of its occurrence will be seen from the accompanying chart.

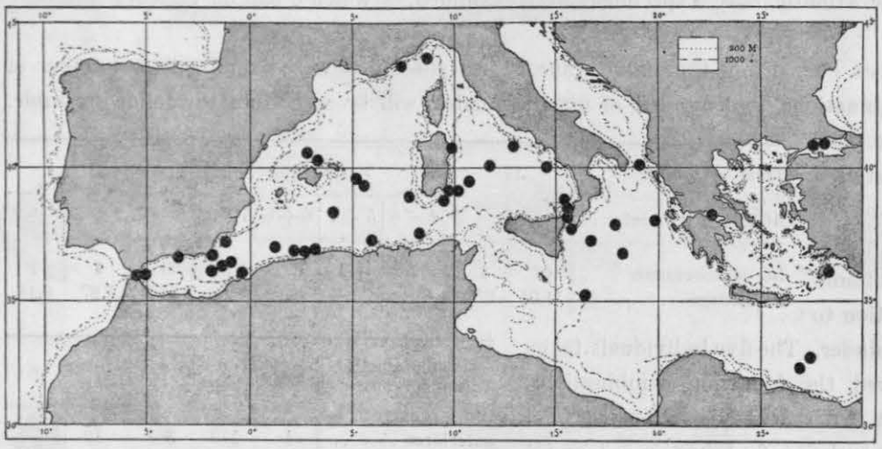

Fig. 16. Distribution of *Myctophum Benoiti* (Cocco), according to the investigations of the "Thor"; adult stages.

The greatest numbers, however, were found in the Alboran Sea and the Balearic Sea, as will be seen from the table below; the figures given likewise show how the number of adult stages decreases continually towards the east.

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Levantine Sea	Marmora
Total no.	190	228	60	53	5	5
No. pr. hour.	24	20	9	7	3	5

No adult specimens were found in the Adriatic or the Ægean, but with regard to the lack of adult stages in the latter water, it should be noted that several stations here yielded postlarvæ which must be referred for the most part to this species. In the Marmora, there seems to be a fairly large stock of these fish; 439 postlarvæ were taken here, doubtless also belonging to this species; as, however, many of them are quite small, I am unable to assert that there may not be postlarvæ of *M. Hygomi* here.

A few of the richest stations may be noted; all are from the Alboran Sea or the Balearic.

The adult stages are found almost exclusively over greater depths, only 35 specimens having been taken inside the 1000 metre limit, of which again only 4 inside the 500 metre limit. The postlarval stages are also, as I have shown in the case of other species, mostly met with over great depths; also, however, to some extent closer in to land, being probably carried in by the currents.

St. 410 ("Pangan") 173 spec.
- 204 ("Thor") 67 -
- 206 — 56 -
- 46 — 36 -

The vertical distribution of the adult stages will be seen from the accompanying table. It will be seen that the species keeps mainly to the upper water layers, save for the greater depths in August and September, (this will be referred to later on).

Most species are found to live higher up in the winter than in midsummer; from the table here, however, this does not seem to be the case with the present form. Possibly this may be in some way connected with the fact that the species in the Atlantic appears as a more northerly or more southerly form, but we cannot decide the point from what is stated in extant literature; further discussion must be postponed until the distribution in the Atlantic has been more closely investigated. It is possible, of course, that the apparent difference may after all be merely due to accidental peculiarities in the composition of the present material (cf. below).

Metres of wire out	Winter		Summer			
	Dec.—Feb.		June—July		August—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25.....	13	4	22	11	98	30
65.....	35	18	3	2	15	12
300.....	10	7	6	4	5	3
>500.....	24	3	15	5	118	17

With regard to the vertical distribution, it will be interesting to compare the vertical occurrence of the largest individuals with that of the smallest. This will be seen from the two tables below.

The first table shows the vertical distribution of the large fish, and includes only sizes over 30 mm. It will be noticed that they were taken almost without exception in the upper 150 metres of water.

The second table shows the vertical occurrence of the smallest adolescent stages, taken by the "Thor" (the S/S "Pangan" took 174 specimens, all under 15 mm, with 112—122. m. w., they are, however, not included in the present survey, as the implements and methods employed were not the same as those of the "Thor"; otherwise, this large catch agrees with what is shown below). The table includes only specimens under 15 mm: i. e. fish having just, or at any rate but recently, passed through the metamorphosis stage. It will be seen that they are found in the very uppermost water layers, and again deeper down, below abt. 500 m. The explanation is, as mentioned, that when metamorphosis sets in, the postlarvæ move (actively or passively?) down towards the deeper water, returning again after metamorphosis towards the surface layers, where the species in its older stages belongs. This ascent seems to take place fairly rapidly, since, as we see, only a very few specimens were taken at the intermediate levels. The greater part of the specimens taken in August and September at greater depths belong to these recently metamorphosed stages. And we may also mention here, that all typical metamorphosis stages of this species were taken at great depths.

Metres of wire out	Winter		Summer	
	No. of spec.	No. of hauls	No. of spec.	No. of hauls
25.....	1	1	3	3
65.....	4	3	4	3
200.....	2	2		
300.....	1	1	2	2
1000.....	..	..	1	1

Metres of wire out	No. of sp.	Percentage
25.....	56	30.1
65.....	6	3.2
200.....	1	0.5
300..... ..	6	3.2
500—1000.....	15	8.1
>1000.....	102	54.9

With regard to the question of vertical migrations from day to night, the material tells us but little. Fiftythree specimens were taken in 12 hauls during the day, by far the greater number with more than 500 m. w., but of these, 33 (in six hauls) were small specimens under 15 mm, i. e. recently metarmorphosed, and thus naturally belong to these depths at that stage of their ontogenetic migration. It should also be noted that some few specimens of over 25 mm were taken in day hauls with 25—200 m. w. The largest one, 36 mm, was taken in a day haul with 200 m. w.; another, of 27 mm., was taken with 25 m. w. (between 9 and 10 a. m.)

The present material thus seems to show that day-to-night migrations are restricted to about the upper 150 metres of water, but here, as with the other species, we can say nothing absolutely definite.

Propagation. A thorough explanation of the propagation in this species is unfortunately hardly possible, since the postlarvæ, as mentioned, cannot always be distinguished from those of *M. Hygomi*. We may point out, however, that there are comparatively few of this species among the postlarvæ from the winter cruise, by far the greater part belonging to *M. Hygomi*. From the summer cruise, we have a good 3000 specimens, most of which doubtless belong to the present species. We are thus able to gain some idea, at any rate, as

to the propagation, especially by comparison with the smallest adolescent stages found. For quantities of postlarvæ, etc., reference may be made to the brief statement appended after the section dealing with *M. Hygomi.*

In connection with this table of sizes for the adult stages during the different months, the following points should be noted: All specimens under 15 mm from the months of December were taken by the S/S "Pangan" in the Alboran Sea. Those from February were nearly all taken in the Alboran Sea by the "Thor". The March material was collected by Capt. G. Hansen on the shore near Messina. The yield for June—July is mostly from the western basin; nearly all those taken in August are from the Balearic Sea, and those in September from the Alboran Sea.

Size in mm	Dec. 1908 & 1911	Jan. 1909	Feb. 1909	March 1911	June 1910	July 1910	Aug. 1910	Sept. 1910
50								
	..	..	..	..	..	..	..	1
	..	..	..	..	..	..	1	1
	..	..	..	..	..	..	..	1
45	..	..	..	1	1			
	..	..	..	1	1	..	..	1
	..	..	..	..	1			
	..	1	..	..	..	..	1	
40	..	..	..	..	..	..	1	
	..	..	..	1				
	..	..	1	1				
	..	1	..	2				
35	..	..	1					
	..	..	1					
	..	1	1					
30	..	..	1					
	..	..	2					
	..	..	1					
	..	1	3	..	..	..	1	
	..	..	1					
25	..	..	3	..	..	..	1	
	..	1	5	..	..	..	1	
	..	..	6	..	..	..	2	
	1	..	5	..	..	..	2	
	1	..	7	..	..	1	1	
20	1	1	9	..	2	..	6	
	1	3	4	..	2			
	..	2	5	..	..	..	6	
	..	2	5	..	3	..	9	
	2	2	6	..	2	2	8	
15	1	..	8	..	1	6	47	
	..	..	8	..	1	6	48	
	8	1	3	..	3	6	30	
	98	..	2	..	9	2	36	
	65	..	..	..	2	1	26	
10	2	..	..	..	..	..	6	

It seems then, on comparison with the postlarval material, that *M. Benoiti* spawns mainly in spring, summer and autumn, though some spawning also takes place during the remaining part of the year. Much would also seem to suggest that the species spawns at somewhat different times in the different parts of the Mediterranean. This should possibly also be considered in connection with the distribution and spawning time of the species in the Atlantic. Most of the typical metamorphosis stages were taken in summer. Further investigation of these questions is, however, much to be desired.

Maturity appears to set in at a length of abt. 40 mm; but a closer investigation of this point would require a larger material than that here available.

The measurements in the literature for specimens of this species do not as a rule exceed the figures in the table above; CARUS, however, notes one of 80 mm (with caudal). This last might seem to suggest that the species may attain an age of more than 1—2 years.

Investigation of the ovaries in the present specimens bears out what we have said above with regard to propagation.

A specimen of 42 mm from January, had only abt. 350 eggs of 0.20—0.23 mm diameter, but a large number of smaller eggs (the ovary was abt. 7 mm long and 1.3 mm broad); while specimens taken in March (Messina) and during the summer, had far larger eggs, and a far greater number developed. The eggs did not exceed abt. 0.5 mm in diameter; none were transparent and fully ripe. The largest ovaries were abt. 10 mm long and 2.5 mm broad. Sometimes the right was larger, sometimes the left, the difference, however, being but slight.

The following numbers of large eggs were found in the ovaries:

Length of fish (excl. caudal)		No. of large eggs
44 Mm.	(March, Messina)	(391 + 458) = 849.
44 -	(June, Alboran Sea)	(290 + 344) = 634.
45 -	(— —)	(388 + 382) = 770.
42 -	(August, Sea of Marmora).....	(614 + 659) = 1273.

MYCTOPHUM HYGOMI (Lütken).

Vert.: 36, *37*; D: *14*, 15; A: 20, *21*; P: 15, 16; V: 8.

Material. Of this species, we have from the Mediterranean proper 65 adult specimens, comprising 42 taken by the "Thor", and 23 by the S/S "Pangan". There was also a large material of postlarval stages; the smaller of these, however, could not, as mentioned, be distinguished from the corresponding stages of *M. Benoiti*, and no definite number can therefore be stated, nor can this material itself be further dealt with for the present.

As regards the Atlantic, the only large quantity of specimens belonging to this species is from the Bay of Cadiz, and no comparison could therefore be made for number of vertebræ, for instance, between the Atlantic material and the Mediterranean.

Literature. The species has been described by LÜTKEN from the Atlantic in 1892; possibly therefore, subsequent investigations may establish the form found in the Mediterranean as a distinct variety. The species has only recently been recorded from the Mediterranean, (ZUGMAYER 1911), represented by unusually small specimens (12 mm) from the Balearic Sea. See also BRAUER 1906.

Postlarval characters. As frequently mentioned in the foregoing, the distribution of the melanophores in the postlarval stages presented no characters by which this species could be distinguished with certainty from the foregoing; one essential reason for this seems to be that the pigmentation is somewhat variable within each of the two species. There is, as a matter of fact, little pigment beyond the ventral, and this is, in *Myctophum* species generally, subject to some variation. I have therefore found it best to give only a couple of the oldest stages, which indubitably belong to this species, having been taken in the same sample as adults of the same, with transition forms as evidence of the connection. Possibly fresh material of postlarvæ may furnish means of distinguishing definitely between the two species.

The postlarvæ of this species are, like those of the foregoing, distinguished from those of *M. glaciale* chiefly by their slenderer form; by having only very faint melanophores on the head, and by the position of the anus, which in all stages is situated immediately at the anterior margin of the anal fin. The largest stages are easily distinguished from *M. Benoiti* by their size alone, metamorphosis in the present species taking place at abt. 13—14.5 mm, whereas the corresponding stages of *M. Benoiti* are about 10—12.5 mm. Other distinguishing features are the slenderer, yet stronger build; the more elongated shape of the eye; slight pigmentation of the body, and stronger pigmentation of the pectoral fin, whereby these stages differ from those of *M. Benoiti*. I should here further point out that careful measurement of length of body, distance from point of snout to anal fin, and similar dimensions, taken together with the degree of development in the fin rays, etc. at various stages among the smaller postlarvæ afford valuable aids to the determination of species, the fin rays in a specimen of *M. Benoiti* being more fully developed than in a specimen of *M. Hygomi* of exactly the same size, — which agrees with the fact that the metamorphosis stages in the former are smaller than in the latter. For investigations of this nature, however, well-preserved specimens are required. I have not been able to deal in this manner with the whole of the present material, which comprises over 4000 postlarvæ.

In this connection, the following should be noted. In specimens of *M. Hygomi* at abt. *11 mm*, the posterior rays of the dorsal are not yet fully developed; there is only a slight indication of photophores (*Brr*) and

large remains of the larval marginal fin-fold are still preserved. *M. Benoiti*, on the other hand, has at this length all the rays of the dorsal developed, the eye is far less narrow, and metamorphosis is not far off (photophores).

In specimens of *M. Hygomi* at *8 mm*, only the anterior basal part of the dorsal is formed; in the anal, the base and rays are partially developed. *M. Benoiti*, at the same length, has nearly all rays of the dorsal clearly formed. The rays of the anal are formed. In this stage also, the eye is less narrow than in *M. Hygomi*.

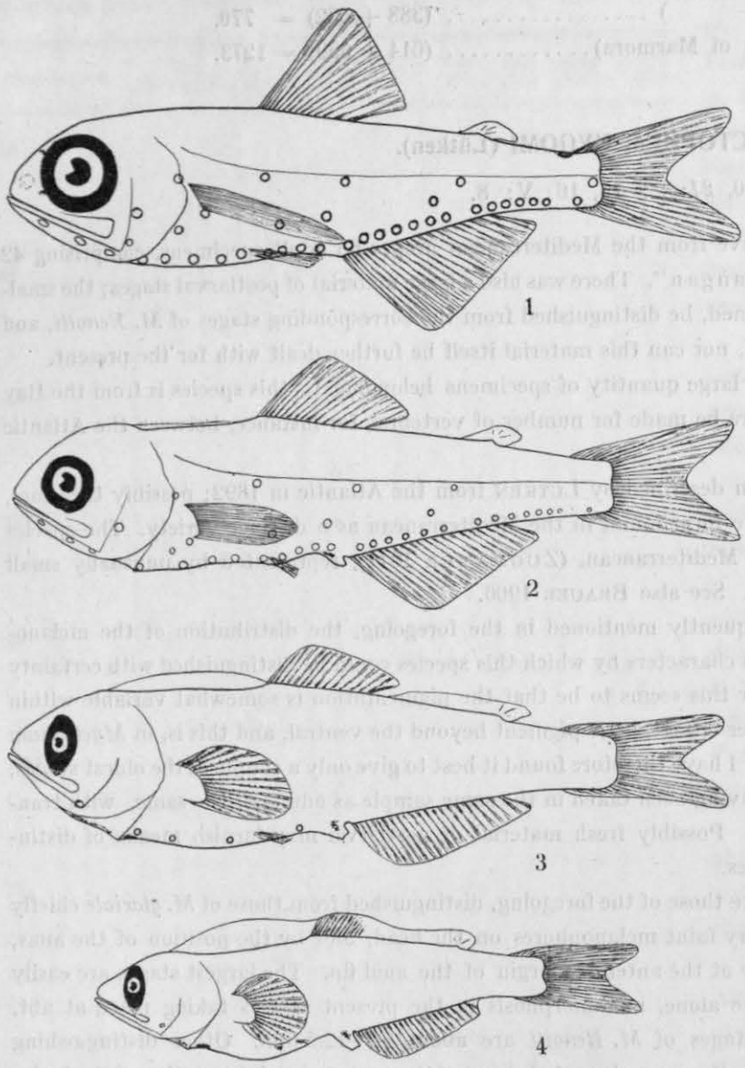

Fig. 17. *Myctophum Hygomi* (Lütken).
1: ad. ♂; 2: metamorphosis stage 13 mm; 3: 14.5 mm; 4: 11.5 mm.

At *7 mm*, *M. Hygomi* exhibits only a slight indication of the dorsal fin, and only the basal portion of the anal is formed. *M. Benoiti*, at this length, has both these fins indicated, though the rays are not yet fully developed. The eye now seems to be the same in both species, and at these stages, with those still smaller, it is on the whole a difficult matter to distinguish between the two species.

The number of fin rays in the two species is so much alike that it cannot be used as a specific character. The postlarva of *M. Hygomi*, however, appears to be somewhat more pointed in the snout at these stages than *M. Benoiti*.

I would further point out that the relation between these two species is in many respects a parallel to that which exists between *Myctophum punctatum* and *M. Humboldti*; from this point of view, we find *M. Benoiti* answering in several features to the former, *M. Hygomi* to the latter, as for instance in the ontogenesis.

14.5 mm. (17.5 mm with caudal). This is the stage immediately preceding metamorphosis. Pectoral large, ventral formed; anal and dorsal have, like the other fins, their full complement of rays distinctly formed, though not of their subsequent normal length; incurvation of the caudal smaller than in the adult stages. The eye has still a very pronounced taper. Remains of the larval marginal fin-fold present, especially the dorsal sinus. Præanal pigment apparent as melanophores on the sides of the anal papilla, and several melanophores farther forward, e. g. at the point of the clavicles. As a rule, there are distinct small melanophores along the rays of the pectoral. Of photophores, we find *Brr.*, a couple of *PO* or more, and a single *VO*, differing slightly in the different individuals.

11.5 mm. (12.5). Pigmentation as in the foregoing. Far larger remains of the larval marginal fin-fold. Dorsal short, and posterior portion not fully formed. Ventral only slightly developed.

It should here be added, that the melanophores on the point of the snout and the point of the lower jaw, as also those on the caudal, are apparently rarely found in this species, but are more frequent in *M. Benoiti*.

The metamorphosis stage is of the usual characteristic appearance. Larval pigment, only slight remains of the præanal. Number of photophores varies individually. Of the typical metamorphosis stages we have four (abt. 13—14.5 mm). The length appears to diminish a little during metamorphosis, the largest postlarva being 14.5 mm. All the typical metamorphosis stages were taken with 1200 m. w. or over, and all in winter (December-January).

Number of fin rays and of vertebræ counted in postlarval stages was found to be in agreement with that of the adults.

EMERY (1883) shows in fig. 14 Pl. 28 a postlarva which must be referred to this species (the length is stated in text p. 410 as 17 mm with caudal). Whether fig. 12—13 should be taken as this or the previous species is, as above mentioned, doubtful. HOLT & BYRNE (1911) refer their fig. 1 Pl. I to *Myctophum punctatum*, to which species, however, it certainly does not belong. In the text p. 20, it is compared with EMERY's figures above mentioned, and there can thus hardly be any doubt that it is the same form. The postlarva shown is 15 mm; the text also notes the finding of specimens of 14—16 mm (without caudal).. HOLT and BYRNE found no adult specimens of this species, which, according to the literature generally, appears to be of somewhat more southerly occurrence in the Atlantic (LÜTKEN 1892).

Adult characters.

BRAUER includes this form in his system only as a variety of *Myctophum Benoiti*. I must, however, from the results of my own investigations, maintain that LÜTKEN is perfectly right in establishing it as a distinct species, though it must be admitted that this point could only be determined after investigations on a broader basis. Unquestionably, the form is very closely related to *M. Benoiti*, as the ontogenesis shows, but the relationship does not seem to be very much closer than what we find between several other species treated in the present work.

The principal characters distinguishing this species from *M. Benoiti* may here he noted.

1. Position of the photophores (*VLO, Pol., SAO* and *Prc.*).
2. Number of *AO*, viz: generally 7 + 6 (in *M. Benoiti*, the figure most frequently occurring is 5 +7 or 6 + 6).
3. The secondary sexual character, at any rate in the males.
4. The number of vertebræ, viz: generally 37 (*M. Benoiti* has most frequently 36).
5. The postlarval stages are at any rate from a length of abt. 7 mm different from the corresponding stages of *M. Benoiti* as regards degree of development, though the position of the photophores may not afford any absolute guide.

It may further be added that the adolescent stages of the two species are readily distinguished one from another, the abdomen in those of *M. Hygomi* being distinctly dark, while in *M. Benoiti* it is quite light in colour; the areas of distribution in the Mediterranean, also, do not altogether coincide for the two species, and the spawning time evidently differs somewhat, *M. Hygomi* spawning more particularly in winter, *M. Benoiti*, on the other hand, during a greater part of the year.

1. Number of vertebræ. Twenty specimens from the Mediterranean were examined; I have not, however, been able to investigate any from the Atlantic. From the western basin, 10 specimens were examined, (St. 45 and 116); all these had 37 vert.; from the eastern basin also 10 were examined; of these, 9 had 37, the tenth 36, (S/S "Pangan", St. 277). The most frequently occurring value for number of vertebræ in this species is thus 37 (15 + 22).

2. Number of photophores etc. From the Mediterranean, I have counted the photophores in 59 specimens. The various combinations and number of maculæ anales will be seen from the accompanying table.

It may be added that in these 59 specimens, eight showed difference in number and in position of the *AO* on right and left sides.

Unfortunately, I had no suitable material of this species from the Atlantic; according to LÜTKEN, it would seem that similar combinations to those for the Mediterranean are here found; which are the most frequent, however, we do not know.

Total no. of *AO* ...	12		13			14	
AO ant. + *AO* post.	6+6	7+5	6+7	7+6	8+5	7+7	8+6
No. of spec.	1	2	2	48	2	2	2
Percentage	1.69	3.39	3.39	81.36	3.39	3.39	3.39

Maculæ anales ant. or post. ..	5	6	7	8
anteriores	..	3	52	4
posteriores	4	51	4	

3. Infra- and supra-caudal luminous plates (the secondary sexual characters).

The material contains only five mature individuals, all males. These are distinguished by a supracaudal luminous plate, situate immediately in front of the short rays in the caudal; the plate is almost circular in shape, possibly slightly oval in the longitudinal direction of the body. The length of the plate varies from 0.5—1.3 mm in specimens from 37—46 mm (excl. caudal). Both shape and size are thus quite different from those of the organ in *M. Benoiti*.

Length of the caudal fin in specimens from 14—17 mm was found to be abt. 3 mm; in specimens of 20 mm it was abt. 5 mm, and in specimens of 37—46 mm abt. 8—10 mm.

Distribution.

M. Hygomi was, as mentioned above, first recorded from the Mediterranean in 1911. In the Atlantic, it appears to be a more southerly form (according to LÜTKEN). The species is also known from the southern Indian Ocean.

Within the Mediterranean proper, it is found more particularly in the Tyrrhenian and Balearic Seas, as will be seen from the chart given; 35 of the adult specimens are from this area. It penetrates, as the chart shows, some way to the east; 16 specimens were taken in the Levantine Sea. In the material from the Alboran Sea, on the other hand, it is hardly represented at all, differing in this respect from the closely related species, *M. Benoiti* and *M. glaciale*. It should be added, however, that the species is fairly numerous in the Bay of Cadiz. The distribution of large postlarvæ which must be referred to this species agrees with this. It is impossible to say with certainty, however, whether the material from the Ægean and the Marmora does or does not contain small postlarvæ of this species.

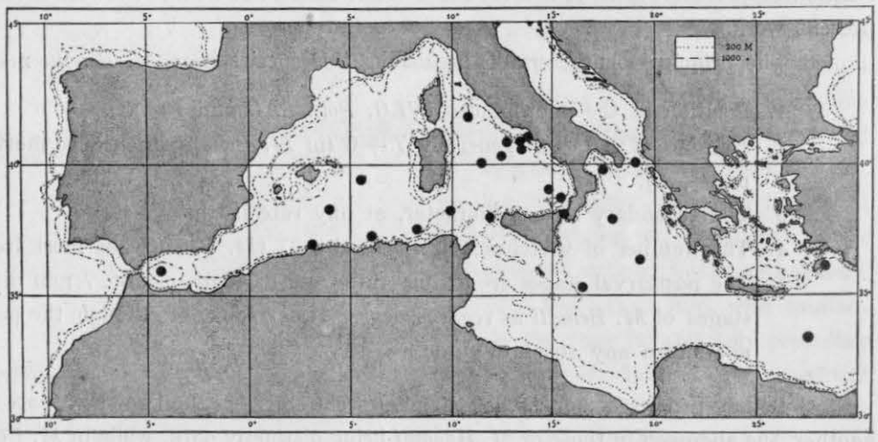

Fig. 18. Distribution of *Myctophum Hygomi* (Lütken), according to the investigations of the "Thor"; adult stages.

The greatest number taken at any station is 15, from St. 277 (S/S "Pangan"); at St. 45 also, 11 specimens were found. The former of these two stations lies in the Levantine Sea, the latter in the Balearic.

This form is, like the other species, found over great depths. Inside the 1000 metre limit, 8 specimens were taken, of which only one (15 mm) inside the 500 metre line. Of seven taken between 500 and 1000 metres, two were of 37 and 46 mm.

Vertical distribution will be seen from the following table. It will here be noticed that this species, like the rest, is found higher up in the water during winter than in summer. I may add that all the species from the "Pangan" April 1911 were taken with 94—132 m. w. Further, that the five mature specimens were taken with 300—1000 m. w. (in summer). The material is, however, too small to serve as basis for discussion of these questions. I would nevertheless remark, that four specimens were taken in day hauls, the rest at night. One individual, (15 mm) was taken during the day in the surface

Metres of wire out	Winter		Summer	
	No. of spec.	No. of hauls	No. of spec.	No. of hauls
15.....	1	1		
25.....	3	3		
65.....	14	4		
100.....	1	1		
200.....	2	2		
300.....	3	1	6	5
600.....	..	..	1	1
1000.....	2	1	3	3
1400.....	2	2		
1600.....	2	2		

layers (65 m. w.), the other three (12—14 mm) with 1000—1650 m. w.; these last must be supposed to belong to the deeper levels, as being recently metamorphosed.

Propagation. With regard to the propagation of this species, but little can be said, as the postlarval material can only partly be included in the investigations.

As already mentioned, all the typical metamorphosis stages were taken during the winter cruise, and such postlarvæ as were identified with certainty for this species are likewise from the winter hauls; the material also shows that the large postlarvæ of 10—14 mm increase in numbers very greatly, at the expense of the smallest stages, below 7 mm, in the course of December—January—February (see the following brief survey of postlarvæ of *M. Benoiti* and *M. Hygomi*).

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	April 1911	June 1910	July 1910	Aug. 1910
45.....	..	..	..	..	1	1	
40.....	..	..	..	..	..	..	1
	..	..	..	..	1	1	
35.....							
30.....							
25.....							
	..	..	..	1			
	..	..	..	2			
	..	..	..	1			
	..	..	..	1	1		
20.....	..	..	..	2	..	1	
	..	..	2				
	1	..	..	1			
	1	1	3	6	..	1	1
	..	1	7	7			
15.....	..	7	3	2	..	..	1
	..	2					
	..	3					
	..	1					
10.....							

A comparison with the above table of lengths for adult stages during the different months also exhibits entire agreement with what we have just seen, the smallest adolescent stages being found for the most part in January—April. Spawning must therefore be supposed to take place in autumn and winter.

As no mature females are found in the material, nothing can be said as to number of eggs in the ovaries, etc.

Postlarval stages of M. Benoiti and M. Hygomi.

As mentioned in the foregoing, it was impossible to distinguish in all cases between the postlarvæ of these two species, and I have therefore here taken the entire mass of material for both under one head.

Postlarvæ of these species were found in all parts of the Mediterranean, but it should be noted, that the identified postlarvæ of *M. Hygomi* are for the most part derived from about the same places where the adults of that species were found. On the winter cruise, postlarvæ were found at 33 stations in 65 hauls; in the summer cruise, at 70 stations in 92 hauls. The winter hauls yielded abt. 975 postlarvæ, the summer abt. 3175; in addition, we have 10 specimens from Messina (March 1911) probably all of *M. Hygomi*. As already mentioned, most of the specimens taken on the winter cruise belong to *M. Hygomi*, and most of those taken in summer to *M. Benoiti*.

The vertical distribution will be seen from the table below.

It will be noticed that the majority of the winter material was taken higher up than the summer catch, a feature which seems to be the general rule among *Scopelids*, both as regards adult and postlarval stages, and it can thus hardly in this instance be due to the fact that we are here dealing with two species at once. A great number of the specimens taken with over 300 m. w. are stages approaching, or actually undergoing, metamorphosis; in addition, it is evident that a very high proportion of these fish, though apparently from great depths, were in reality not taken there, but were caught while drawing up the net; most of them were taken at stations where a particularly rich haul was obtained from the water layers above.

Metres of wire out	Winter	Summer	
	Dec.—Jan.	June—July	Aug.—Sept.
25.....	213	261	368
65.....	494	449	275
300.....	90	712	430
>300.....	39	150	299

The material tells us nothing with regard to day-and-night migrations among these postlarvæ, which were taken both day and night in the upper water layers. Migration, if any, must therefore be presumed to cover a short distance only, and will not be discernible by the methods employed on this expedition.

The following table shows the amounts of the different stages during the various months.

Size in mm	Winter						Summer							
	Dec.		Jan.		Feb.		June		July		Aug.		Sept.	
	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%
>10.....	42	9.7	212	49.1	64	59.2	100	10.8	159	24.1	82	8.5	45	7.2
7—10.....	182	41.8	163	37.7	38	35.2	594	64.3	334	50.6	370	38.4	194	30.9
<7.....	211	48.5	57	13.2	6	5.6	230	24.9	167	25.3	511	53.1	389	61.9

The great majority of the postlarvæ taken on the winter cruise belonged, as we have seen, to *M. Hygomi*. And although fishing was carried out in different areas during the three winter months, and the spawning time may perhaps not be the same for all localities, there is nevertheless a so distinct increase discernible in the number of large and decrease in that of the small specimens in the course of these three months, that we may doubtless regard this as indicative of the growth of the postlarvæ within the period in question.

The material from the summer cruise does not show this marked increase in the number of larger and decrease in that of the smaller specimens. This is doubtless due to several causes. In the first place, the summer hauls covered far more heterogeneous localities than the winter cruise (from the Alboran Sea in to the Sea of Marmora), and, as noted for *M. Benoiti* and other species, the spawning time appears to differ in the different areas. In the second place, the summer material is hardly so homogeneous as that from the winter; there seems, at any rate in places, to be an intermixture of postlarvæ of *M. Hygomi*, though we cannot say to what extent this applies to the postlarvæ (abt. 1300) under 7 mm taken during the summer cruise.

The material from the month of August includes 450 specimens belonging to the smallest group, 174 of the intermediate, and only 18 of the largest in the eastern basin and the Marmora, especially the latter; the remainder of the August yield is chiefly from the Balearic Sea.

It thus seems as if the spawning time in the Marmora falls later than in most, if not all, other parts of the area investigated by the "Thor".

The sudden increase in the quantity of the quite small postlarvæ from the Alboran Sea during September might appear incomprehensible when compared with the conditions noted for June in the same water when the smallest sizes seem considerably fewer; possibly, however, it may be due to supplies from the Bay of Cadiz, (the inflowing current being strongest in September[1]), and not to any unusual lateness in the spawning time for *M. Benoiti* in the Alboran Sea. It might also be imagined that *M. Hygomi* had then commenced spawning, and that this had given rise to the conditions noted. The question should be considered together with what is noted in the following with regard to *Diaphus Holti* and *Lampanyctus crocodilus*.

MYCTOPHUM PUNCTATUM, Rafinesque.

Vert: 40; D: 12, 13, *14*; A: 19, *20*, *21*; P: 14; V: 8.

Material. We have 1432 specimens of this species from the Mediterranean, comprising 1256 postlarval stages and 176 adults. In addition, I have had a smaller material from the Atlantic.

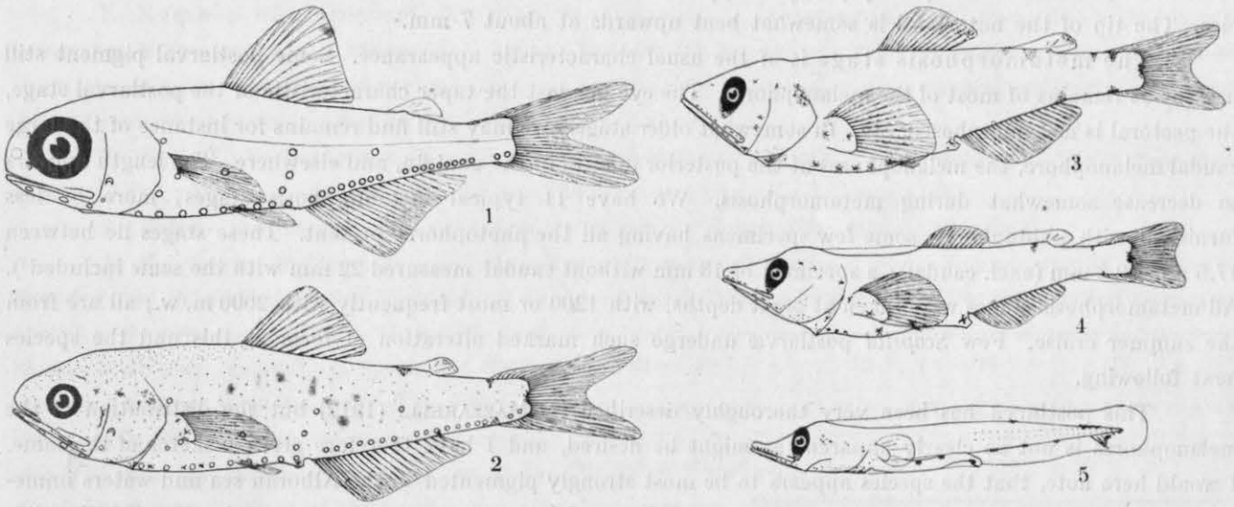

Fig. 19. *Myctophum punctatum*, Rafinesque. 1: ad. ♂; 2: metamorphosis stage 18 mm; 3: 16 mm; 4: 10.5 mm; 5. 5.7 mm.

Of the Mediterranean material, two large specimens (53 and 61 mm) and 1 postlarva were taken at Messina by Capt. G. Hansen; the remainder by the "Thor".

Literature. The species was described from the Mediterranean by RAFINESQUE (1810) and has been mentioned from there by many writers. I would here point out that LEYDIG (1881) shows in fig. 38—39 Pl. VI what he states to be *M. Benoiti*; it is, however, really *M. punctatum*, as the fine illustration clearly shows. See also BRAUER (1906) for literature concerning this species.

Postlarval characters. *16 mm* (19 mm with caudal). This stage, which comes somewhat before the metamorphosis, may be characterised as follows. Shape elongated; pectoral large, though not reaching quite to the anus; ventral not yet full length; the same applies to dorsal and anal. Incurvation of the caudal not so deep as in adults. Eye with distinct taper. Little or no remains of the larval marginal fin-fold (the dorsal sinus).

Præanal pigment on the anal papilla, and in larger or smaller melanophores right out to the head. Dorsal pigment apparent as more or less sharp, partly internal spots at the adipose fin, as also at and in front of the

[1] J. N. NIELSEN: Hydrography of the Mediterranean, p. 171. Report on the Danish Oceanographical Expeditions 1908—1910. Vol. I. Copenhagen 1912.

anterior dorsal rays of the caudal. Ventral pigment as more or less sharply defined spots, especially prominent at the posterior margin of the anal fin and anterior ventral rays of the caudal. At the base of the caudal, (in the median line) there is a large, prominent melanophore. Pigment often visible on the posterior part of the dorsal and anal, as also on the adipose fin. At the point of attachment for the pectoral, and along the rays of the same, there are small melanophores. A number of melanophores on the head, those on the upper margin of the gillcover are especially prominent, as also the row of small melanophores following the upper and lower jaw and branchiostegal rays. No indication of photophores.

Particularly characteristic are the melanophores in the caudal region.

10.5 mm (12.25). This stage differs from the foregoing especially by its more larval appearance, which is particularly apparent in the considerable remains of the larval marginal fin-fold, and in the shape of the snout, which is longer, much flattened and broad. The ventral fin only slightly indicated. Pigmentation mainly as in the foregoing; at any rate, the most characteristic melanophores of the species are present.

5.7 mm Tail diphycercal, but with indications of the caudal fin. Pectoral present, otherwise no indications of any fins. Larval marginal fin-fold intact. Snout considerably longer and flatter than in the foregoing stage. Melanophores markedly prominent; most of those later apparent are already visible here, as also a couple of ventral ones which subsequently partly disappear, as is often the case with these melanophores in various species. The tip of the notochord is somewhat bent upwards at about 7 mm.

The metamorphosis stage is of the usual characteristic appearance. Some postlarval pigment still present as remains of most of the melanophores. The eye has lost the taper characteristic of the postlarval stage, the pectoral is metamorphosed, etc. In somewhat older stages, we may still find remains for instance of the large caudal melanophore, the melanophores at the posterior margin of the anal fin, and elsewhere. The length appears to decrease somewhat during metamorphosis. We have 11 typical metamorphosis stages, more or less furnished with photophores, some few specimens having all the photophores present. These stages lie between 17.5 and 19.5 mm (excl. caudal); a specimen of 18 mm without caudal measured 22 mm with the same included[1]). All metamorphosis stages were taken at great depths, with 1200 or most frequently with 2000 m. w.; all are from the summer cruise. Few *Scopelid* postlarvæ undergo such marked alteration of form as this and the species next following.

This postlarva has been very thoroughly described by Mazzarelli (1912) but the distribution of the melanophores is not so clearly apparent as might be desired, and I have therefore given a sketch of the same. I would here note, that the species appears to be most strongly pigmented in the Alboran sea and waters immediately adjacent; less so towards the east. The same thing seems to apply to certain other species (e. g. *M. Benoiti*).

The postlarva of this species has been described and figured several times. I do not consider, however, that Mazzarelli is correct in referring Emery's fig. 14 (1883) to this species. Lo Bianco (1903—04) shows what must doubtless be two stages of this form (fig. 17 and 19, Pl. 8). Holt and Byrne (1907), fig. 5 (?). Ehrenbaum (1905—09) shows on p. 354 this or at any rate a closely related Atlantic form. Mazzarelli treats the species several times (1909, 1910 and 1912), most thoroughly in his extremely fine work on the postlarvæ of this and the following species from 1912. He considers, however, that the larva (*Stylophthalmoides Lobiancoi*, Mazz.) should be classed under *Stomiatidæ*. Fage (1910) mentions it on p. 17—20 (*a*); like Mazzarelli, he is disinclined to refer it to the *Scopelids*, partly on account of the fact that no indications of photophores are discernible, even in the largest specimens. It is also characteristic of the species that all the photophores are evidently formed quite suddenly. Otherwise, in the *Myctophum* group, we generally find one or more organs indicated even in very small stages. Possibly, however, we may just be able to discern a *Brr* in postlarvæ of abt. 19 mm. Holt and Byrne (1911) describe the postlarva as stages of *Scopelus crocodilus*, Risso (p. 27—28, fig. 2—7, Pl. I). Regan (1916) shows a postlarva (fig. 5, Pl. VI) which he refers to *Lampanyctus macropterus*; this postlarva doubtless

[1] According to the "Thor" material from the Atlantic, the metamorphosis stages here are larger than those in the Mediterranean (abt. 21—22 mm as against 17.5—19.5 mm).

belongs somewhere in the immediate neighbourhood of this species (NB. the eye, the large caudal melanophore, etc.). BRAUER (1908) shows in his fig. IV, p. 167 what is evidently a closely related species.

L. SANZO (1914—15) was the first to note that this postlarva belongs to *M. punctatum*[1]).

MAZZARELLI states[2]) in a reference to JOHS. SCHMIDT's investigations of the *Leptocephali* in the Mediterranean, that the postlarval stages of this (and the following) species in the Strait of Messina are as a rule represented by large individuals, rarely by small, and he observes, that we might therefore equally well apply to these species the argument advanced by JOHS. SCHMIDT for the *Leptocephalus brevirostris* as proof of its Atlantic origin. Now in the first place, MAZZARELLI says nothing whatever as to which of the two species is meant, or at what time of the year his postlarvæ were taken (as I have shown below, it is perfectly possible to find almost exclusively large postlarval stages of this species at a certain season). But apart from all this, it is extremely daring to make comparison between the postlarvæ of the eel and those of the *Scopelids*. The postlarval period of the former covers a period several times as long as that of the latter, and this alone precludes any immigration of postlarval *Scopelids* from the Atlantic to Messina, the impossibility of which will also be further demonstrated in various ways at various parts of the present work.

Adult characters.

1. Number of vertebræ. Vertebræ were counted in 20 specimens, all from the main area of occurrence of the species, the Alboran Sea and the Balearic (St. 50, 108 and 218); in all cases, the figure was 40. From the Atlantic, countings of vertebræ were made with only 7 specimens, from various stations; the average showed one vertebræ more than in the Mediterranean form (41).

2. No. of photophores etc. The maculæ anales were counted in 100 specimens. The various combinations and number of *AO* ant. and *AO* post. will be seen from the following table.

Total no. of *AO*	15		16		17		18
AO ant. + *AO* post.	7+8	8+7	7+9	8+8	8+9	9+8	9+9
No. and percentage	4	1	10	52	29	3	1

Maculæ anales ant. or post.	7	8	9
anteriores	14	82	4
posteriores	1	59	40

3. Infra- and supracaudal luminous plates (the secondary sexual characters).

In the present material, 6 specimens showed supracaudal luminous plates (males) and 13 infracaudal (females). In the males, we find 1—3 fused plates immediately in front of the caudal fin; the smallest specimens, in which the organ is only just discernible, are 35 mm long (excl. caudal); in specimens below this size, nothing is to be seen. The plates in these males (35—60 mm) covered at the outside 2.75 mm. In the females, there are 3—5 continuous plates in front of the caudal, extending out between the last *AO* post. to between the third and second *AO* post. from the last; as a rule, the organ is first discernible at a length of 38—40 mm (excl. caudal); in one specimen of 34 mm, however, there is just a slight indication visible; at smaller stages, there is nothing to be seen. The plates in these females (34—61 mm) covered at the outside 4.0 mm.

Lengths of the caudal fin as follows.

In specimens of abt. 20 mm the length of the caudal is abt. 4.5 mm
— — 30 - — — — 7 -
— — 40 - — — — 9 -
— — 50 - — — — 12 -
— — 60 - — — — 14 -

[1] I was not myself acquainted with SANZO's work; it was not until the conclusion of the present investigations, in the autumn of 1917, that I found it mentioned in MAGRINI: The Objects and Work of Royal Italian Oceanographical Committee. Venezia 1916. (Compare p. 5—6 foot-note).

[2] E. MAZZARELLI: Note critiche sulla Biologia del'Anguilla. (Revista di Pesca e Idrobiologia). Pavia 1914, p. 51.

Distribution. *Myctophum punctatum* has been frequently found in the western basin of the Mediterranean, especially near the Strait of Messina, as is also the case with the best-known *Scopelids* from the remaining parts of the Mediterranean. It is known from the Atlantic and the Pacific.

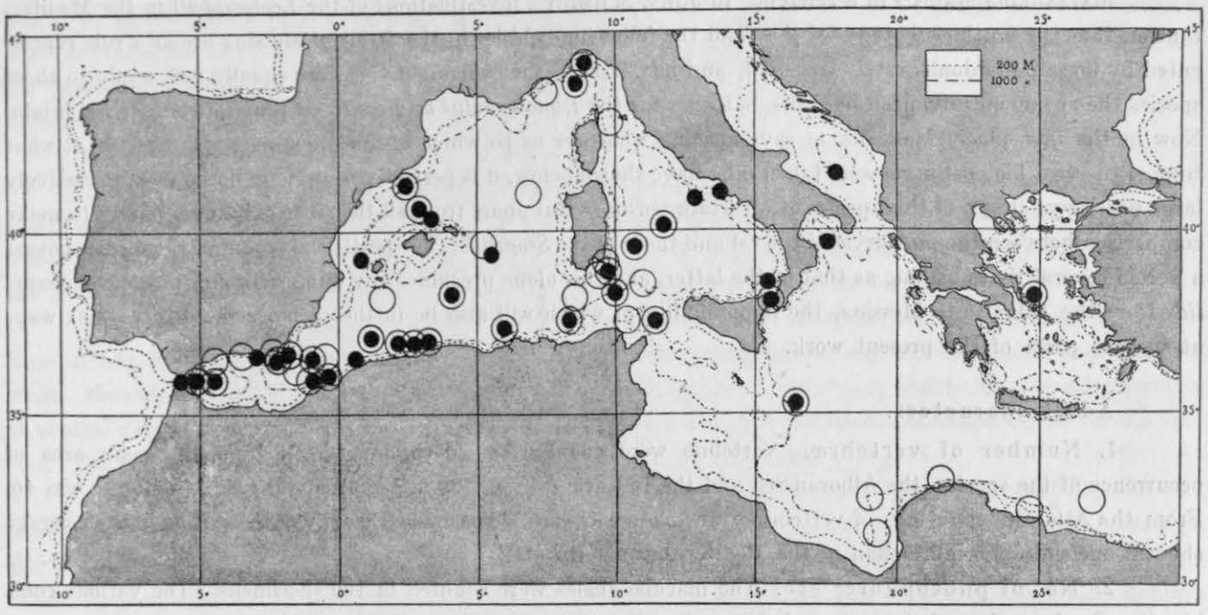

Fig. 20. Distribution of *Myctophum punctatum*, Rafinesque, according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

The distribution in the Mediterranean will be further seen from the accompanying chart. It will be noticed that it is found but sparsely in the east, but may be met with right up in the Ægean. The principal area of occurrence both for adults and postlarval stages lies far to the west, in the Alboran Sea and the Balearic, as is plainly evident from the figures below:

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Adriatic Sea	Levantine Sea	Ægean Sea
Adults	83	73	9	3	1	0	2
Postlarvæ	1059	136	14	31	0	6	3

Finally, a few of the richest stations may be mentioned (from the principal area of occurrence)

Adults:

St. 50.... 16 spec.
- 118.... 19 -
- 218.... 16 -

Postlarvæ:

St. 57.... 153 spec
- 99.... 102 -
- 104.... 124 -
- 107.... 102 -
- 108.... 297 -

By far the greater part of the adults were taken over great depths. The postlarvæ appear to be found to some extent also closer in to land. This is the case in the Alboran sea during winter, as already shown for instance with *M. glaciale*, to which reference may be made for this question (at St. 55, 57 and 58 in the Alboran Sea, a total of 292 postlarvæ of *M. punctatum* was taken).

The vertical distribution of adult stages will to some extent be seen from the accompanying table; the material of this species, however, is not very large, and does not seem to give any very distinct idea of the

Metres of wire out	Winter		Summer			
	Dec.—Feb.		June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr hour	No. of spec.	No. pr. hour
25	6	2	14	11	54	17
65	13	7	15	6	1	4
300	5	3	21	7	7	6
1000—2000	2	2	20	3	6	2

conditions. It is nevertheless clearly seen that the great majority were taken with 25—65 m. w. With this species, we do not seem to find, as with *M. glaciale*, any very marked difference between the depth at which the specimens are taken in winter and that where they are found in summer; this is, however, possibly due to lack of material. For specimens taken in the deepest layers, see below.

With this species, as with others, it is interesting to note where the mature and the smallest adolescent stages were taken.

As will be seen from the following, the largest fish, over 35 mm, were found almost exclusively in the upper water layers, 25—65 m. w.; the day hauls show not a single specimen of these sizes at greater depths.

Length of wire in metres	No. of spec. > 35 mm	No. of hauls
25	7	7
65	8	5
300	1	1
1000—1200	2	2

Of the smallest adolescent stages under 25 mm, the material has 104 specimens in all. The vertical occurrence of these will be seen from the following.

Length of wire in metres	No. of spec. < 25 mm	No. of hauls	Percentage
10—25	41	13	39.4
65	16	8	15.4
300	24	10	23.1
600	3	3	2.9
1000—2000	20	9	19.2

On comparing with the above table for vertical distribution of all adult stages together, we find that the great bulk of those taken at greater depths are these smallest adolescent stages under 25 mm (20 out of 28). As with most other species, then, so also here we find that these adolescents belong either to greater depths or to the upper water layers, in accordance with their ontogenetic migration. As shown above, only 2 specimens over 35 mm were taken with 1000—1200 m. w. (in two hauls); and possibly, these were not actually taken at the depth indicated, but while hauling up the net.

The largest postlarval stages (over 15 mm) show the following vertical distribution.

Length of wire in metres	No. of spec.	Percentage
25	0	0.0
65	30	24.6
300	69	56.6
over 300	23	18.8

These figures, then, indicate a downward movement (active or passive) of the largest postlarvæ; it may be added that in the whole material of postlarvæ, only 87, or 7%, were taken with over 300 m. w.

Vertical distribution of the postlarval stages will be seen from the following table.

Here again we find a difference between the winter and summer distribution; as with other species, the postlarvæ are found during midsummer deeper down than in winter. It will be seen from the following that most of the summer yield was taken in June. It should further be added that the greater part of the specimens taken in winter with 25 m. w. are from the northern part of the Alboran Sea (St. 55, 57 and 58); in this connection, reference should be made, as noted above, to *M. glaciale*.

Metres of wire out	Winter		Summer	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	140	93	0	0
65	75	21	205	91
300	49	10	605	43
> 500	5	3	82	7

Finally, it should be noted that the postlarvæ in summer appear to live deeper down east of the Alboran Sea than in that water, the postlarvæ found east of there being almost without exception taken with 300 m. w. or more. Possibly this may be found to stand in some relation to the question whether the species in the Atlantic keeps more to the north or more to the south; in any case, the point should be borne in mind.

With postlarvæ under 15 mm, there does not appear to be any difference between the depths at which the different stages live. The present material also gives no indication of any vertical day-to-night migration.

With regard to the question of day-to-night migration in the adult stages, the following should be noted.

By far the greater number were taken in night hauls, and as shown, the largest individuals in these were found near the surface. The day hauls yielded 6 specimens, taken in 5 hauls with 600—2000 m. w. Five of these specimens were under 25 mm, and thus probably belong naturally to these depths at that stage of their ontogenetic migration; one specimen was 27 mm long.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	March 1911	June 1910	July 1910	Aug. 1910	Sept. 1910
	..	..	..	1				
60	..	1						
	1							
55								
	..	..	..	1	..	..	..	1
	..	..	..	..	1			
50								
	..	..	..	..	1			
45	..	..	..	..	1			
	..	..	..	..	1			
	..	..	..	..	..	..	..	1
40	..	..	..	..	1	2		
	..	..	..	..	..	..	1	
	..	..	..	..	..	..	..	1
	..	..	..	..	..	..	..	1
	..	..	1	..	..	..	1	1
35	..	..	..	..	1	..	..	4
	1	..	..	..	2	..	..	1
	..	..	..	..	2			
	..	..	..	..	..	1	..	1
30	..	..	..	..	1	..	..	1
	..	1	..	..	1	.	..	4
	..	..	..	..	..	..	..	2
	..	..	..	..	2	..	..	2
	..	..	1	..	4	..	..	2
25	..	..	2	..	9	1	1	3
	..	..	..	..	5			
	..	..	2	..	5	1	1	4
	..	..	2	..	5	5	2	7
	1	..	3	..	8	2	..	8
20	..	..	2	..	3	1	3	11
	..	..	6	..	3	..	1	1
	..	..	9	..	2	..	2	1
	..	..	..	..	1			
15								

Propagation. *Myctophum punctatum* belongs to the larger species, specimens of abt. 100 mm being known.

Spawning appears to take place for the most part from winter to some way on in summer, with maximum in spring, as will be seen from the following table showing number and size of postlarvæ at different times of the year. The investigations cover the months of February, June and September, when the "Thor" was fishing in very nearly the same parts of the chief area of occurrence. In the three months, the following numbers of postlarvæ were taken, with the yield pr. positive hour as shown:

	Total no.	No. pr. positive hour
February	360	31
June	769	80
September	36	12

It will be observed that there is a marked decrease in the course of the two months, from June to September.

Size in mm	Feb.		June		Sept.	
	No. of sp.	%	No. of sp.	%	No. of sp.	%
15—20	7	1.9	100	13.0	9	25.0
10—15	57	15.8	329	42.8	16	44.4
7—10	244	67.8	296	38.5	11	30.6
<7	52	14.5	44	5.7	0	0.0

In the course of the three months, the percentage of larger fish increases, while that of the smaller sizes decreases. The reason why so comparatively few small stages under 7 mm are taken is doubtless the same here as in the case of other species, viz: that the smallest stages, with their diphycercal tail, and fins but incompletely formed, etc. are more delicate, and are destroyed in the nets. Small species, and those of firmer and more compact build (as for instance *M. glaciale* and *Lampanyctus maderensis*) are at these stages (6—7 mm) far better able to

stand rough handling in the nets than the present species, *M. glaciale* on account of its more advanced development, and *L. maderensis* by its structure on the whole.

A comparison of the tables above for occurrence of postlarvæ at the different times, and of the spawning time as it seems to appear from this, with the table for sizes of adults in the various months in which they were taken, shows a pretty fair agreement between the two.

Maturity does not appear to be reached until a length of over 45 mm. As to the age of specimens 60 mm long or more, the slight amount of material gives no idea. That the species can, however, attain an age of several years, would seem likely, from the finding of specimens abt. 100 mm long.

Investigation of the ovaries showed that the largest were 13 mm long, and 3.5 mm broad (in a spec. of 61 mm); the smallest ovary, in a specimen of 40 mm, with eggs quite undeveloped, was 4 mm long and abt. 1 mm broad. The most ripe eggs were found in specimens from March-September; size of the eggs in these abt. 0.40 to 0.43 mm diameter.

The following numbers of large eggs in the ovaries were counted:

Length of fish (excl. caudal)	No. of large eggs
51 mm (June)	(435 + 494) = 929
52 - (September)	(430 + 364) = 794
61 - (March)	(411 + 420) = 831

MYCTOPHUM HUMBOLDTI (Risso).

Vert.: 39, *40*; D: 13, *14*; A: 21, *22*, 23; P: 13, *V*: 8.

Material. There are 259 specimens of this species from the Mediterranean, 210 being postlarvæ and 49 adults. The majority were taken by the "Thor", but 3 adults by the "Pangan", and 5 postlarvæ at Messina by Capt. G. Hansen. I have also had a smaller material from the Atlantic.

Literature. The species was described from the Mediterranean by Risso in 1810; Risso's name has at any rate been employed by later writers. It might, however, seem open to doubt whether Risso's figure (fig. 38, Pl. X) really represents this species, as the shape of the head, length of the mouth cleft, etc., hardly agree with what we otherwise find in this form. Several writers have been in doubt as to this figure and its text. The species is recorded by many writers from the western part of the Mediterranean; Leydig (1881) gives a figure (fig. 57 Pl. X); it is, however, not this species, but *M. Benoiti* (cf. what is stated above as to Risso's figure).

Postlarval characters. I will here confine myself to stating briefly the distribution of the pigment in postlarval stages; the species has, like the foregoing, been described in detail by Mazzarelli (1912).

17 mm (20 mm with caudal). This stage, which comes somewhat before the metamorphosis, may be characterised as follows. Elongated shape, but of heavier build than the foregoing species. Pectoral very large, extending behind the anus[1]). Ventral merely indicated. Posterior portion of dorsal not fully formed. The fins have not the length and shape subsequently attained. Eye with distinct taper. Very considerable remains of the larval marginal fin-fold; the dorsal sinus in particular is very large. Præanal pigment: a few melanophores. On the head, a very large melanophore at the posterior margin of the gill cover; some pigment also on the point of the snout and point of the lower jaw. On the pectoral, markedly prominent melanophores along the rays, and especially at base of same. No other pigment present (nothing, for instance, of the caudal pigment so characteristic of the preceding species). Indications of *Brr* can be discerned (this photophore may be indicated in specimens from 12 mm length).

[1] This character, which clearly distinguishes the postlarvæ of this species from those of the foregoing, is found again in the adult stages, where the pectoral is always longer in *M. Humboldti* than in *M. punctatum*. This is not distinctly apparent from the illustrations of adult stages given in the literature; it is best seen in Holt and Byrne (1911).

8.3 mm (9.25). Does not differ greatly from the foregoing stage in respect of position of the melanophores, but is of course far more larval in appearance; the larval marginal fin-fold, for instance, is intact, the tail has not yet its subsequent form, the upturned portion of the notochord is extremely distinct, the snout is longer than in the foregoing stage and much flattened, as in the foregoing species, the pectoral fin very large (about $^1/_3$ the entire length of the individual).

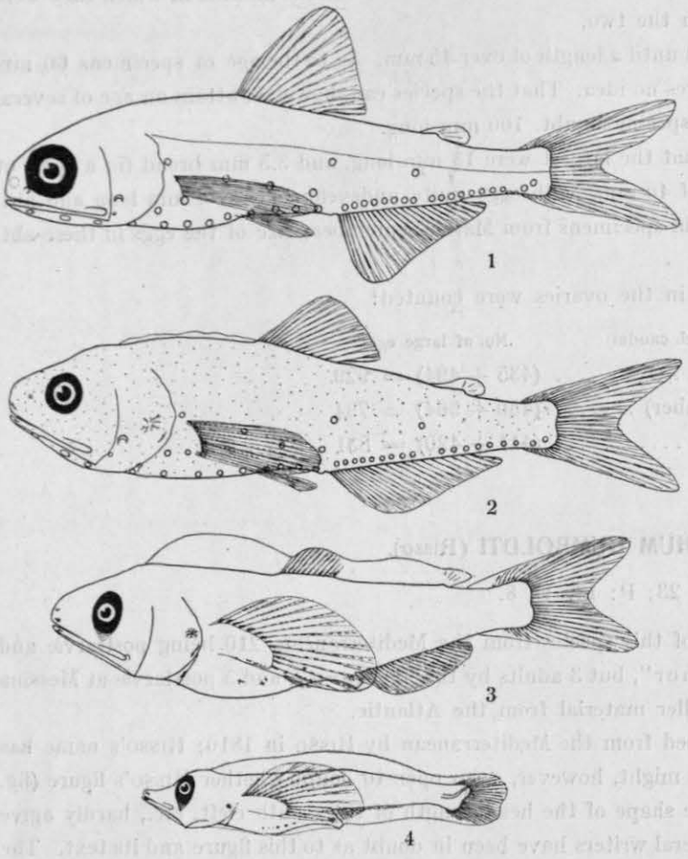

Fig. 21. *Myctophum Humboldti* (Risso). 1: ad. ♀; 2: metamorphosis stage 20 mm; 3: 17 mm; 4: 8.3 mm.

The material includes specimens down to 6 mm.

The metamorphosis stage is represented by only a single specimen of 20 mm (25 with caudal). We have postlarval stages up to 21 mm long (26 with caudal), and there seems thus to be a certain diminution of length in the metamorphosis. The metamorphosis stage shows distinct remains of the characteristic melanophores, and has still some traces of the large dorsal sinus, which we seldom find in the metamorphosis stage. The specimen in question was taken with 2000 m. w.

This postlarva was first mentioned and figured by EMERY (1883) who shows (fig. 10 and 11, Pl. 28) two stages of this very characteristic form. MAZZARELLI mentions it in 1909, 1910 and 1912 under the name of *Stylophthalmoides mediterraneus*, MAZZ. and refers it, like the foregoing, to the *Stomiatidæ*. This writer has, as mentioned above, given a fine and detailed description of this species in his work of 1912. FAGE (1910) mentions the species together with the foregoing (p. 17—20 (*β*)); I should, however, here remark that I have never in any specimen found so long rays in the pectoral fin as FAGE shows in his figure. SANZO mentions, in 1914—15, that this postlarva belongs to *M. Humboldti* (see footnote under *M. punctatum* p. 59).

Adult characters.

1. No. of vertebræ. Vertebræ were counted in 23 specimens from the Mediterranean; of these, 14 were from the Ionian Sea, (St. 13) comprising 6 with 39 and 8 with 40 vertebræ; 9 were from the Balearic Sea (St. 118); one of these specimens had 39 vertebræ, the remaining 8 had 40. These few counts thus show lower figures in the eastern part of the Mediterranean. Further investigations are much to be desired with respect to this feature, especially as the species exhibits remarkably low number of vertebræ in the Atlantic, where 13 specimens investigated gave only values of 37 and 38. LÜTKEN had already (1892) observed a difference between the Mediterranean form and that from the Atlantic and Indian Ocean, (p. 254), those living outside the Mediterranean showing a smaller number of maculæ anales post. It will be noticed that this entirely agrees with what I found in the case of the vertebræ.

2. Number of photophores etc. The maculæ anales were counted in 38 specimens from the Mediterranean. The various combinations of *AO* ant. and *AO* post. are shown in the following table.

Total no. of *AO*	15		16		17
AO ant. + *AO* post.	7+8	8+7	8+8	9+7	8+9
No. of specimens	3	9	21	4	1
Percentage	7.9	23.7	55.3	10.5	2.6

Out of 36 specimens, 10 exhibited a difference between right side and left in number of *AO* ant. and *AO* post.

3. Infra- and supracaudal luminous plates (the secondary sexual characters). The present material includes one specimen with supracaudal luminous plates (male) and 5 with infracaudal do. (female).

Maculæ anales ant. or post.	7	8	9
anteriores	3	31	4
posteriores	13	24	1

In the male (80 mm) we find two continuous small plates, covering only 2.0 mm. In the females, (up to 87 mm) there are 2—4 small plates, which in the largest specimens extend over 4 mm. The position of the plates is otherwise the same as in *M. punctatum*.

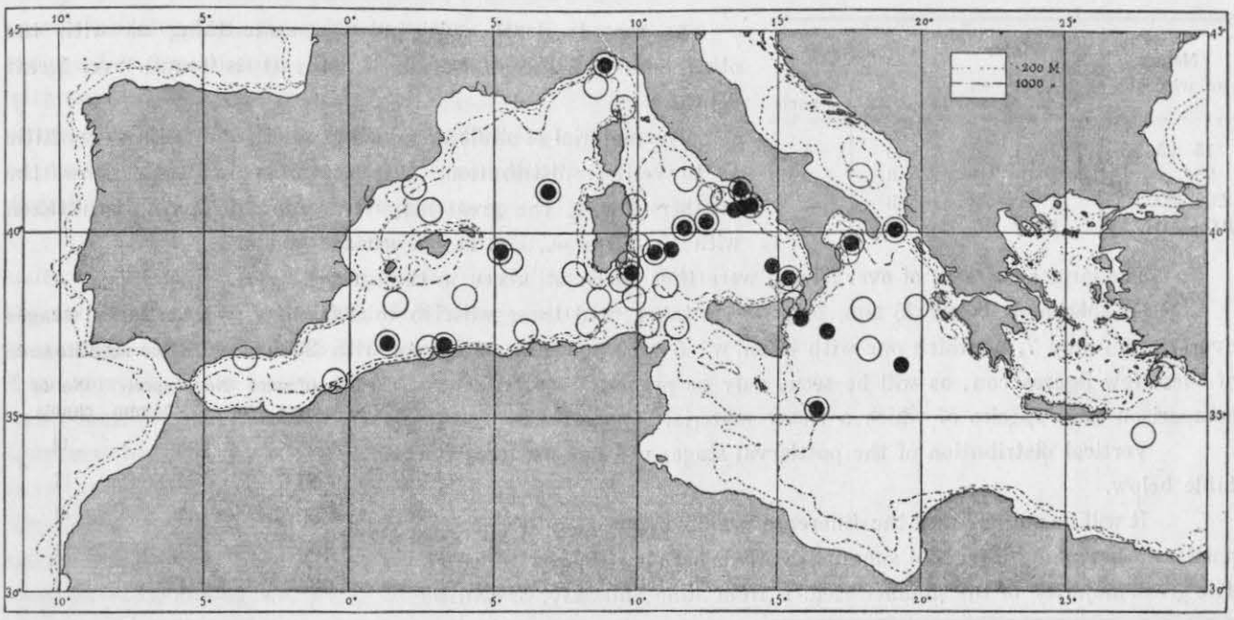

Fig. 22. Distribution of *Myctophum Humboldti* (Risso), according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

In specimens below 40 mm, there is hardly any trace of these præcaudal plates to be seen. The length of the caudal fin appears to be as follows:

In specimens of abt. 20 mm the caudal fin is abt. 5 mm long.
— — 30 - — — 7 —
— — 38 - — — 9 —
— — 58 - — — 13 —
— — 85 - — — 16 —

Distribution. Besides the Mediterranean and the Atlantic, this form is also known from the Indian Ocean and the Pacific. In all probability, it will be found that it is not properly to be regarded as a single species. Like the remaining species belonging to this genus, it is best known in the Mediterranean from the immediate vicinity of the Italian coasts, and as will be seen from the following, the Italian waters also constitute its principal area of occurrence in the Mediterranean.

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Adriatic Sea	Ionian Sea	Levantine Sea
Adults	0	13	12	0	22	0
Postlarvæ ...	3	70	55	1	15	5

The spawning area seems very nearly to coincide with that where most adults were found. The species does not, however, appear to be very numerously represented in comparison with other related forms. The greatest number taken at any one station is 16 (St. 13 in the Ionian Sea), while 9 were taken at St. 118 in the Balearic; otherwise, most of the stations yielded only single specimens. The postlarvæ also were not particularly numerous at any locality; the richest stations are as follows:

St. 26 (Tyrrhenian Sea) ..... 14 spec.
- 123 (Ligurian Sea) ..... 46 -
- 206 (Balearic Sea) ..... 12 -

Metres of wire out	Winter		Summer	
	No. of sp.	No. of hauls	No. of sp.	No. of hauls
15—25	22	8	6	5
65	1	1	6	2
200—300 ...	4	3	3	2
1000—2000 ..	1	1	3	3

As regards depth, we find the same thing as with the other forms of the *Myctophum* group; it is found over great depths.

The material of adult stages is but small, and tells us very little as to vertical distribution. The accompanying table shows the numbers found; the great majority appear to have been taken with 15—65 m. w., i. e. in the surface layers.

The large specimens of over 35 mm were thus nearly all taken in the surface layers.

Of specimens below 25 mm, only 6 were taken, and these with 15 to 2000 m. w.; of postlarval stages over 15 mm only 7, of which one with 65 m. w., 5 with 300 m. w. and one with 2000 m. w. The significance of these few figures can, as will be seen, only be properly understood by comparison with species of which a richer material is available.

Length of wire in metres	No. of specimens > 35 mm	No. of hauls
25	4	4
65	1	1
200	1	1
300	1	1
1000	1	1

Vertical distribution of the postlarval stages will be seen from the table below.

It will be noticed that the difference usually apparent in the case of postlarvæ between winter and summer depth is here less clearly indicated. The great majority of the summer yield is from June and July, as will be seen from the next table. It should here be noted, however, that in winter, most of the positive hauls were made with 65 m. w., in summer, with 300 m. w.; 46 out of the 53 specimens taken in summer with 65 m. w. were taken in one haul (St. 123).

Metres of wire out	Winter		Summer	
	No. of sp.	No. pr. hour	No. of sp.	No. pr. hour
25	13	2	4	4
65	32	2	53	35
300	18	3	47	5
> 500	5	2	23	2

From Messina, we have, as mentioned, 5 postlarval stages, taken in March.

As regards vertical day-to-night migrations, no such can be observed in the case of the postlarvæ. In the case of the adults, we find that nearly all specimens were here, as usual, taken in night hauls. Only two specimens were taken in day hauls, and of these, one was the largest of all those taken (87 mm) and was caught on the 20. January (St. 27) between 6 a. m. and 8 a. m., with 65 m. w. The other specimen, of 26 mm, was taken with 1200 m. w. We thus find, that even at this hour of the day, a specimen of this large size can be taken quite near the surface.

Size in mm.	Dec.—Feb. St 11—50		June—July St. 115—143		Aug.—Sept. St. 186—218	
	No. of spec.	%	No. of spec.	%	No. of spec.	%
15—20	5	6.8	1	1.1	1	3.0
10—15	27	36.5	26	28.0	14	42.4
7—10	41	55.4	59	63.4	17	51.6
< 7	1	1.3	7	7.5	1	3.0

Propagation. *M. Humboldti* is, like the foregoing, one of the largest known species of this genus; specimens up to 120 mm are known (COLLET 1896; CARUS); as far as we can see, it would appear to attain an even larger size than *M. punctatum*.

Spawning takes place apparently throughout the greater part of the year, though probably at its height in the spring.

The table here given (p. 66) shows the material of postlarvæ from the principal area of distribution at three different seasons; from the figures given, it will be noted that the smallest postlarvæ, under 10 mm, are almost equally numerous at each of the three seasons concerned, though there are most in June—July. The occurrence of small adult stages throughout most of the year, as indicated in the accompanying table, seems to coincide with this. The paucity of postlarval stages below 7 mm must, as in the case of the previous species, be regarded as due to their being more delicate than other young *Scopelids* of the same size.

Maturity does not apparently set in until a quite considerable size is reached; as to the age of the fish at the stage in question, nothing can be said at present. A specimen of 58 mm had ovaries only 8 mm long and 1.2 broad; the eggs also were quite undeveloped. The specimens taken in the winter (January) had the eggs in the ovaries quite undeveloped; in a specimen of 75 mm, where the ovaries were 12—13 mm long and 2.2—2.5 mm broad, nearly all the eggs were abt. 0.02 mm; in another of 87 mm the ovaries were 18—19 mm long and 4 mm broad, with a number of eggs abt. 0.25 mm diameter, and also a quantity of quite small eggs.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	April 1911	June 1910	July 1910	Aug. 1910
	..	1					
85							
	..	..	..	..	..	..	1
	..	..	..	..	..	..	1
80	..	1					
75	..	1					
58	..	1					
40							
	..	1					
	..	..	..	1			
35	..	1					
	..	..	..	..	..	1	
	..	..	..	..	..	1	
30	..	..	..	1	1	1	1
	..	..	..	1	2		
	2	1	..	..	2	1	
	2	..	..	..	1		
	7	..	..	..	1	2	
25	4	..	1	..	..	1	
	2						
	2						
	..	..	1				
20	..	..	..	..	..	..	1

One of the specimens from the summer, taken in August (82 mm long) had ovaries 20 mm long and 5 mm broad; this specimen contained about 2800 large eggs, abt. 0.38 mm diameter.

MYCTOPHUM COCCOI (Cocco).

Vert.: *40, 41*; D: 11, *12*; A: *21, 22*, 23; P: 15, 16; V: 8.

Material. We have only 27 adult specimens of this species from the Mediterranean, and 37 postlarval stages. Of the adults, only one specimen was taken by the "Thor", the remainder being from the "Pangan". All the postlarvæ were taken by the "Thor". From the Atlantic, there is a large quantity of material, taken, however, for the most part by merchant vessels using the surface net[1]). The reason why the "Thor" found so

[1] BRAUER notes that the greater part of the material of this species which he had to deal with was likewise taken by merchant vessels with the surface net, whereas the "Valdivia" found none (BRAUER 1906, p. 334).

few, while the merchant vessels took extremely many, is probably, that this form belongs to the surface water, (it has a marked silvery lustre) and is therefore only taken by implements working quite at the surface.

Literature. The species was described from the Mediterranean by Cocco (1829) and is very well known and often mentioned in the literature. Brauer (1906) shows in Pl. XVIII the wide distribution of this form in the Mediterranean, Atlantic, Pacific and Indian Ocean. For literature, see also Brauer (1906.)

Postlarval characters. *12 mm* (15 mm with caudal). This stage, which is evidently somewhat before the metamorphosis, may be characterised as follows. Shape high and laterally compressed. Pectoral large, indications of the ventral; rays of the dorsal and anal fin fully formed, but not yet of full length; incurvation of the caudal smaller than in the adult stage. Very considerable remains of the larval marginal fin-fold. The eye oval, running down below into a very long taper, which is not pigmented, but finely striped.

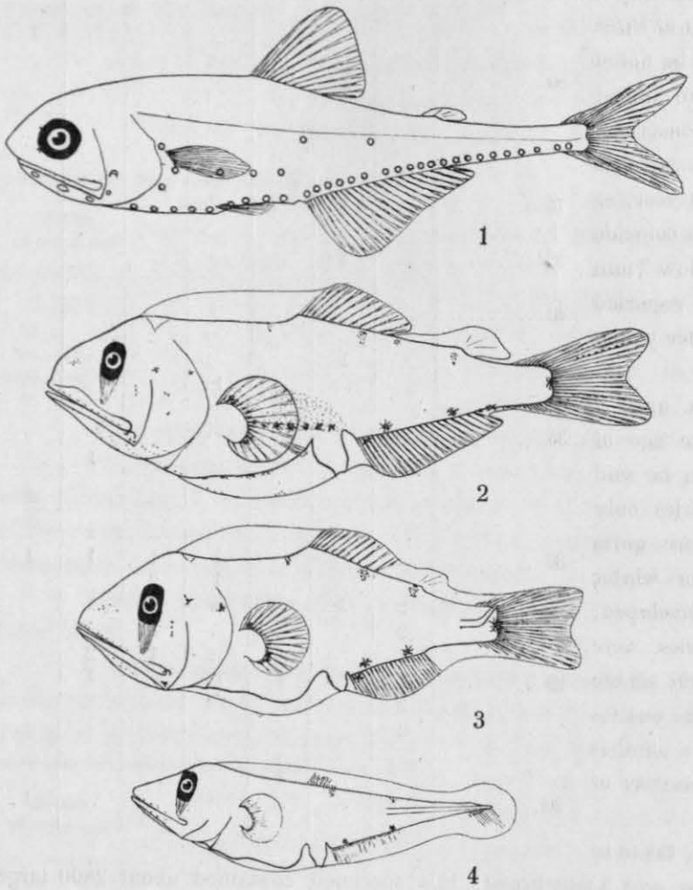

Fig. 23. *Myctophum Coccoi* (Cocco). 1: ad.; 2: 12 mm; 3: 7.5 mm; 4: 5 mm.

Abdominal pigmentation partly as diffuse internal pigment, partly as an oblique row of melanophores commencing a little in front of and above the ventral fin and terminating over the anus. Præanal pigment as small scattered melanophores, not on the anal papilla. Dorsal pigment in several internal accumulations, in front of the anterior margin of the dorsal fin, at the posterior margin of the same, between it and the adipose fin, and on a level with the latter. Ventral pigment is apparent in a couple of large melanophores along the anal fin, and often as pigmentation between this and the caudal. On the anterior portion of the anal, there is a smaller melanophore near the base. At the base of the caudal, there is a large melanophore, and small ones may occur along the rays of the same fin. On the pectoral, likewise melanophores; on the head, several here and there; some also on the branchiostegal rays and along the jaw. Of photophores, only indication of *Brr.*

7.5 mm (9). Pigment partly as in the foregoing stage. General appearance far more larval. The ventral hardly indicated, but the remaining fins seem to have all their rays formed. Larval marginal fin-fold intact. The upturned portion of the notochord visible.

5 mm. Tail almost diphycercal, but some indication of the caudal fin. The dorsal, anal and pectoral little formed, but the basal portion present. This stage has less pigment than those previously mentioned; there are, however, two or more of the very characteristic dorsal and ventral melanophores. The snout somewhat flattened.

There are no metamorphosis stages of this species in the material. I can, however, I believe, refer this postlarva with some degree of certainty to *Myctophum Coccoi.* The number of rays in dorsal, anal and pectoral

agrees with what we find in the adult stages. The material includes only postlarvæ from the same area where adult stages were found (some adult specimens of the species have, however, also been taken previously elsewhere in the western Mediterranean). From the Bay of Cadiz and the Atlantic we have postlarvæ of this form, as also a large number of adults. The eye in this postlarva is somewhat different from that in the remaining species of the *Myctophum* group, but that it does belong to this, and not to the *Diaphus* or *Lampanyctus* group, is evident from the number of fin rays, preservation of the larval marginal fin-fold up to the oldest stages, and from the pigmentation, which last, by the way, somewhat resembles that of *M. punctatum*. Within the *Myctophum* group, it appears most nearly allied to *M. punctatum* and *M. Humboldti*, and can thus only be imagined as belonging to *M. Coccoi*, or possibly a species very closely related thereto; if the latter, then the form in question has not been taken by the "Thor", nor is it represented in the collections made by merchant vessels in the Mediterranean.

Adult characters.

1. No. of vertebræ. I have only counted the vertebræ in 10 specimens from the eastern basin of the Mediterranean ("Pangan" St. 340); the figures 40 and 41 were found. From the Atlantic also only 10 specimens were examined for no. of vert. (from 37°40′ N, 36°24′ W; S/S "St. Thomas", St. 392). The same figures were also found for these.

2. No. of photophores etc. BRAUER (1906) has counted the maculæ anales in a large number of specimens (333 in all); the few counts I have been able to make with Mediterranean material appear in part to coincide with BRAUER's results, though I have not met with the value 17 for *AO*, which BRAUER found was of comparatively frequent occurrence. (BRAUER's material seems to be mainly from the Atlantic). The combinations found in my specimens from the eastern basin of the Mediterranean were as follows.

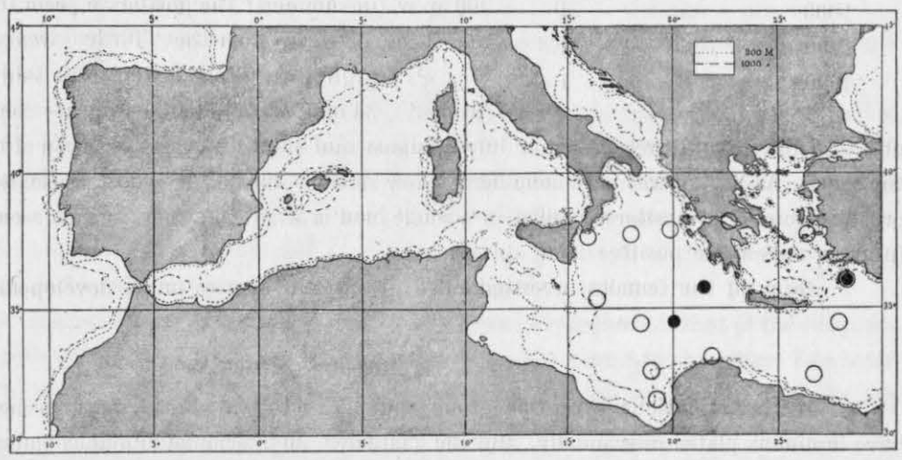

Fig. 24. Distribution of *Myctophum Coccoi* (Cocco), according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

One specimen had 3 + 12 on the left, 6 + 12 on the right side, the three foremost *AO* ant. sin. not being formed at all; this case must be regarded as altogether abnormal. Of the 24 specimens here noted in which the photophores were counted, 11 showed a difference between right and left sides. In a single instance, two *Pol* were found serially (only on the left side).

Total No. of *AO*	18		19	
AO ant. + *AO* post. .	5 + 13	6 + 12	6 + 13	7 + 12
No. of specimens ...	3	12	6	3

Maculæ anales – ant. or post.	5	6	7	12	13
anteriores	3	18	3		
posteriores	..	..	..	15	9

3. Infra- and supracaudal luminous plates (the secondary sexual characters). Only 5 specimens in the material exhibited indications of secondary sexual characters, or had such developed; the sizes of these individuals ranged from 26 to 34 mm (excl. caudal). LÜTKEN and BRAUER also state that specimens under 30 mm have only exceptionally any indication of these organs. The supracaudal plates were found best developed in a male of 34 mm, where there were 7 plates situate supracaudally from the

posterior margin of the adipose fin to the caudal; the plates seemed isolated one from another. A female of 33 mm had 3 roundish spots between the last *AO* post. The position and number of these organs is similar in *M. Andreæ*.

Distribution. The species is known, as already mentioned, from all the equatorial oceans of the globe; it is evidently a warm-water form. As noted, the present material includes only specimens from the eastern basin of the Mediterranean (and from the Atlantic). Adult specimens have, however, previously been found in the western basin. As far as the Mediterranean is concerned, however, postlarvæ have hitherto only been taken in the warmer eastern basin.

The specimen from the "Thor" (19 mm) was taken with 1000 m. w.; all those from the "Pangan" (26 in all) with 28 m. w., i. e. close to the surface. This species, which evidently moves in shoals, was only taken in night hauls, all made in places with soundings over 1000 metres.

Length of wire in metres	Total no.	No. of hauls
25	4	2
200	1	1
300	23	10
600	1	1
1000	5	4
1200	2	1
4000	1	1

Postlarval stages were likewise only taken over great depths, with 800 metres to bottom or more. The vertical distribution will be seen from the accompanying table; it will be noted that the majority were taken with 300 m. w. (in summer); the postlarvæ seem thus to live fairly deep down at that time of year when the "Thor" was working in the eastern basin.

Propagation. Very little can be said as to this. The adult stages (from 17—34 mm) were taken in August—September. The postlarvæ (from abt. 5 to abt. 12 mm) were taken in July—August and only in the eastern basin of the Mediterranean, as noted on the chart. As fishing was only done here at few stations during the winter cruise, the facts tell us but little. The greatest number of postlarvæ taken in a single haul is 5, so that they do not seem to occur in great numbers, (number taken per positive hour abt. 4).

None of the females investigated (3 in all) had ovaries much developed.

Subgenus ***Diaphus.***

My investigations with this group showed that two of the four species found in the Mediterranean have luminous plates præcaudally, and the character "no præcaudal luminous plates" cannot therefore be applied to all species of the *Diaphus* group. It is worth noting, that the luminous plates are found in just those two species which have the frontal photophores very slightly developed in comparison with most other *Diaphus* forms, and even though no secondary sexual difference may be apparent in the structure of these frontal organs, the point should be borne in mind (the size of the frontal organs?).

Facciola (1883—84) already mentions the supracaudal luminous plate in *Diaphus Gemellarii*, but does not venture to assert any definite connection with the sex. Lütken (1892) had a specimen of the same species with supracaudal luminous plate; this has evidently escaped the attention of Brauer. In *Diaphus Dofleini*, the feature was first observed and mentioned by Fage (1910) who shows a male of this species (fig. 7 Pl. 1). Zugmayer (1911), who has described this latter species, also mentions the feature in question.

And here I would also touch on another question in connection with the characterisation of *Diaphus* species. It will doubtless be convenient in dealing with the entire subgenus *Diaphus* to reckon throughout with one *Pol*, never with two; otherwise, unnecessary confusion will arise in describing the species of the group, as it must often be a matter of personal judgement whether one *Pol* or two are found.

On going through the postlarval material from the Mediterranean, I found four different types which had to be referred to the subgenus *Diaphus*. One of these I at first supposed to belong to the species *Diaphus*

metopoclampus, although the number of fin rays did not agree with the values recorded in other works for the same. On revising the material (adult spec.) which had in the first instance been sorted out under the specific names of *Diaphus Gemellarii* and *Diaphus Rafinesquei*, I found that there were in reality four species, of which one new to science; these will be described below. Here again we find how extremely precise is the position of the photophores within each separate species. I propose to name the new species *Diaphus Holti*, in honour of Mr. E. W. L. Holt of Dublin, this author being the first who has ever identified a postlarva of the genus *Myctophum*.

With regard to the subgenus *Diaphus*, I have endeavoured to give a brief description of each of the four species, for the most part following Brauer, and a semi-schematic figure, showing the position of the photophores, fins, etc., and also to note for each species such records in the literature as may fairly be said to belong there.

As already mentioned, *Diaphus Gemellarii* and *Diaphus Dofleini* do not seem naturally to belong to the *Diaphus* group. I will here note the most important points in which they differ from the two other Mediterranean *Diaphus*-species.

1. Supra- and infracaudal luminous plates are found in accordance with sex (as in most species of the *Myctophum* group).

2. The antorbital photophore is quite small, and no other orbital photophores are found, (partly as in the *Myctophum* species).

3. The pectoral fin in postlarvæ is of a quite peculiar shape, not met with, as far as we know, in any other species within the four groups of the genus.

On the other hand, the position of the photophores is that always found, in the main, in *Diaphus* species, and the photophores themselves are divided by a septum as in this group. In the largest postlarvæ, a septum can be seen in some of the photophores; in *Diaphus Dofleini*, however, the septum is not nearly so pronounced as in the other species, and the photophores are altogether less distinct. The postlarvæ resemble in several respects those of the other two *Diaphus* species, and hardly seem to fit in either beside postlarvæ of the subgenus *Myctophum* or those of the subgenus *Lampanyctus*.

There is thus no very sharp limitation either in the case of the subgenus *Myctophum* or that of the subgenus *Diaphus*; as, however, certain principal characters appear to place the two species nearer to the latter, I have included them here, though perhaps it might be most correct to place them in a special subgenus e. g. under the name *Pseudodiaphus*.

It is remarkable that *Diaphus metopoclampus* (Cocco) was never found by the "Thor" in the Mediterranean among the many thousand specimens taken; we have not even any postlarval stages which can be referred to this species. All records in the literature, however, — and it is only mentioned from the Mediterranean — note it as a very rare form. According to Mazzarelli (1909) it is found at Messina in May.

I was nevertheless so fortunate as to have two excellent specimens of this species at my disposal, and am thus also able to assert without hesitation that it is not found in the "Thor" material from the Mediterranean. The two specimens in question (abt. 35 mm excl. caudal) are both from the Atlantic, where the species has not previously been found; they were taken by the M/S "Margrethe", 9. Oct. 1913, at 27°39′ N, 52°50′ W. Both agree fairly well with the descriptions, which themselves differ a good deal one from another. In respect of frontal photophores, structure, etc. my specimens agree well with the illustrations I have found of the species (Cocco, Bonaparte, Raffaele, Goode & Bean, and Brauer). I have below included a frontal diagram of *Diaphus metopoclampus* for comparison with the two species *Diaphus Rafinesquei* and *Diaphus Holti*. The number of fin rays agrees with that given by several writers (D: 15; A: 15; P. 10—11); the number of *AO* is 6 + 5 (Brauer gives 6 + 6 or 6 + 7); the cleft of the mouth, however, seems to reach a little farther back than in the specimen shown by Brauer (1906) in fig. 147, but agrees in this respect, for instance with Bonaparte's figure.

With regard to literature dealing with this species, I may mention the following.

Cocco (1829) — here after Okens Isis 1831 — gives the number of fin rays for this species as D: 13; A: 15 and P: 10. In his more detailed description of 1838, however, Cocco has D: 15; A: 15 and P: 9. Bonaparte

(1832—41) gives the last-named values for no. of fin rays. CUVIER et VALENCIENNES (1849) base their description of this species on a specimen from BONAPARTE. The number of fin rays is stated (p. 443) as D: 12; A: 14; and P: 10. The text further states: "Je n'ai pu rien voir, sur les exemplaires conservés dans l'alcool, de ce singulier appareil lumineux couvrant le devant du museau dans cet espace qui est deux fois aussi grand que l'œil". LÜTKEN (1892) mentions having seen a specimen in the Paris Museum "presented by BONAPARTE and therefore doubtless authentic". He further gives *AO* as 6 + 4, and finds "no essential difference from *S. Rafinesquii*". This, compared with the description given by CUVIER et VALENCIENNES, and with my figures for numbers of fin rays in the different species as given below, certainly seems decisive proof of confusion between *Diaphus Rafinesquei* and *Diaphus metopoclampus*. And unfortunately, a printer's error in BONAPARTE's coloured plate, where the names *Myctophum Rafinesquii* and *Myctophum Gemellari* are transposed, has occasioned still further confusion in CUVIER et VALENCIENNES, the subsequent descriptions of *Scopelus Rafinesquii* and *Scopelus Gemellari* being affected thereby.

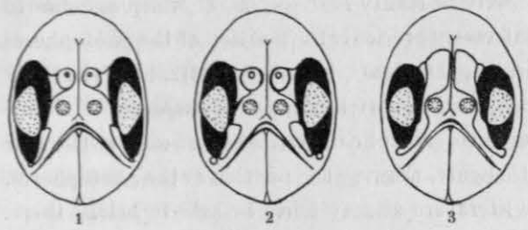

Fig. 25. Diagrammatic representation of the frontal luminous organs: 1: *Diaphus Rafinesquei*, 2: *D. Holti* and 3: *D. metopoclampus*.

LEYDIG (1881) shows in Pl. X the head of a *Diaphus* species (fig. 56) referred with query to *Scopelus metopoclampus*; the specimen doubtless belonged to the species *Diaphus Holti* described below. RAFFAELE's fig. 6 (1889—91) must, from the position of the frontal photophores and shape of the body, evidently be referred to this species and no other; RAFFAELE himself, in the text, points out that the position of the photophores in his illustration must be received with caution. In addition, RAFFAELE had also BONAPARTE's excellent figure to study, and from this fact alone, there can hardly be any doubt that RAFFAELE's figure actually represents this species. GOODE & BEAN (1895) had a specimen from Messina. BRAUER's description (1906) of this species is the best and most exhaustive up to date.

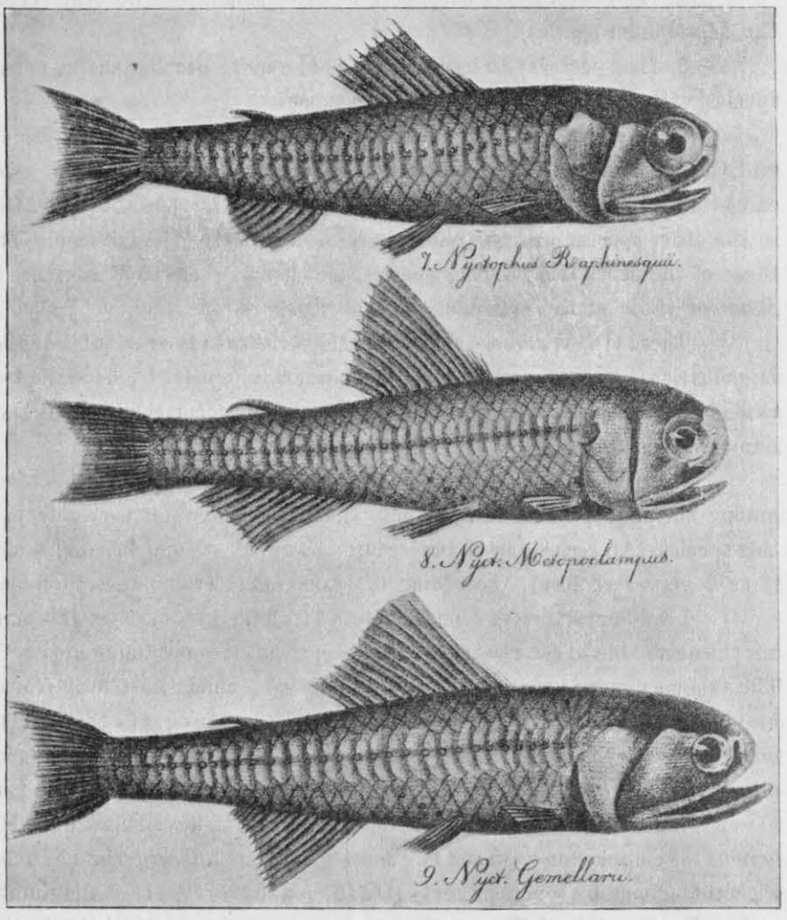

Fig. 26. Cocco's figures of *Diaphus Rafinesquei*, *Diaphus metopoclampus* and *Diaphus Gemellarii* from 1838.

We find, then, that the literature dealing with this species reveals considerable difference of opinion, and indeed, with the *Scopelids* generally, it is only by the application of accurate modern terminology in describing the position of the photo-

phores that the different species of this little varying genus can be brought into proper order. And in many cases, where the type specimens are not preserved, it will doubtless be a matter of individual judgement which name is to have the preference.

DIAPHUS GEMELLARII (Cocco).

Vert.: (abt. 36, counted in postlarvæ); D: 16, *17*; A: 13, *14*; P. abt. 11; V: 8. (BRAUER, 1906, gives D: 16—17; A: 14—15; P: 12).

Specific characteristics. As there is but a single specimen of any size belonging to this species in our material, I here give measurements of the same, referring for the rest to BRAUER's description.

Total length (excl. caudal)	24 mm
Maximal height	6 -
Minimal —	2.5 -
Length of head	8 -
Diameter of eye	abt. 1.8 -
Point of snout to posterior margin of jaw	6 -
Point of snout to dorsal	11 -
Length of dorsal	4.8 -
Point of snout to anal	15
Length of anal	4 -
Point of snout to adipose	18.5 -

The maxillaries only slightly expanded behind. Insertion of pectoral low, this fin not reaching to base of ventral. Origin of dorsal a trifle in advance of ventrals. Anal begins a little in advance of hind margin of dorsal, ending about below adipose fin. Slenderer than the species next following.

Photophores. 1. *Antorb.*: one very small, dorsally to the nostril. 2. *AO*: 5 + 6 (in the two present specimens with all photophores)[1]); the hindmost *AO* ant. lies much higher than the others, and appears like a second *Pol*; foremost *AO* post. a little higher than the rest. 3. *PLO* nearer to the pectoral fin than to the lateral line. 4. *VLO* situate abt. midway between the ventral fin and the lateral line, but nearest the former. 5. Uppermost *SAO*, *Pol* and last *Prc* distant from lateral line, situate lower than in the species next following. Uppermost *SAO* a little in front of foremost *AO* ant. 6. The four *Prc* lie in a slightly curving line at almost the same interval one from another.

Material: see below.

Literature. Descriptions undoubtedly pertaining to this species are given by: Cocco (1838)[2]), EMERY (1883), who has described and figured the postlarvæ, but without knowledge of their connection with the older stages, FACCIOLA (1883—84), who described the species under the name of *Scopelus uracoclampus*, RAFFAELE (1889—91), LÜTKEN (1892), whose specimen was evidently a male, GOODE and BEAN (1895) and BRAUER (1906—1908), who shows the species in fig. 130 (probably a female, from Messina). With regard to several other cases where mention is made of *Diaphus Gemellarii*, I must point out that it is not clear to which of the two related *Diaphus* species the specimen belongs. This species would seem to be the one more frequently found at Messina, (which is in accordance with its distribution in the Mediterranean and that of the following form) and is thus more likely to be the one on which most descriptions would be based. BONAPARTE's figure, for instance, (1832—41) also appears to be of this species. We must therefore retain the name given by Cocco (1838) for this species.

[1] cf. RAFFAELE and BRAUER.

[2] See fig. 26.

Postlarval characters. In this species, we lack the stage immediately preceding metamorphosis. EMERY's fig. 8 Pl. 28 (1883) here serves to supplement the present material. The two stages shown by EMERY (fig. 7 and 8) are of 13.75 and 17.00 mm with caudal fin.

10 mm (12.5 with caudal). Shape rather short. Pectoral divided into two parts, the upper with long rays, the lower having no rays formed. In a specimen of abt. 10 mm, abt. 9 rays may be counted in the upper part of the pectoral, the lower of these being less distinctly formed. EMERY notes 10 rays in his older specimens. The base of the pectoral is of peculiar shape, as will be seen from the sketch here given. The ventral distinctly formed; anal and dorsal have, like the ventral, the normal quota of rays distinctly formed, though not yet of full length; the same applies to the rays of the caudal. Larval marginal fin-fold not present. The eye almost circular.

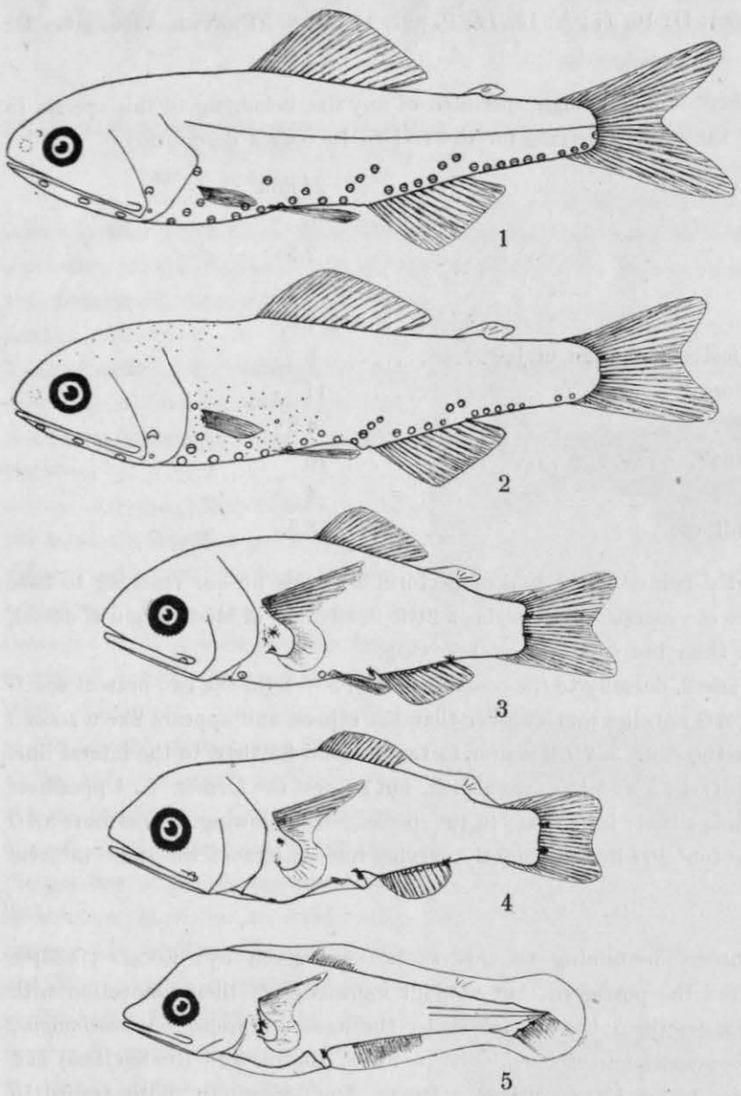

Fig. 27. *Diaphus Gemellarii* (Cocco). 1: ad. 24 mm; 2: metamorphosis stage 14 mm; 3: 10 mm; 4: 7 mm; 5: 5 mm.

Præanal pigment present only as a melanophore on the side of the anal papilla and at times a single melanophore farther forward, e. g. at the point of the clavicles. Ventral pigment at the base of the anal fin; the hindmost melanophore is, as in the next following species, particularly strong. At the base of the caudal, there are two highly prominent melanophores, one on the upper half and one on the lower half of the base; at times they may be secondarily somewhat divided into smaller ones. (These melanophores are distinctly shown in EMERY's drawing; FAGE (1910), however, has omitted them in his copy — fig. 12). There are a couple of larger and smaller melanophores at the base of the pectoral; on the ventral, some small melanophores. Of photophores, *Brr.* is present, as also the foremost and hindmost *PO*. I may here observe that a large, somewhat defective specimen, abt. 10.5—11 mm, showed a number of small melanophores scattered about above and behind the pectoral, as found in the following species; the specimen in question had also the usual melanophores etc. characteristic of the species.

7 mm (8). Pigment as in the foregoing, but general appearance far more larval. Indications of the ventral fin, remains of the larval marginal fin-fold occur in specimens of this size. Of photophores, a slight indication of *Brr.* (Indications of foremost and hindmost *PO* are discernible already at a length of 8 mm).

5 mm. Tail almost diphycercal, but the caudal fin is distinctly indicated, and has the two melanophores

at its base. Larval marginal fin-fold intact. Dorsal and anal but slightly developed, the latter, however, being the farther advanced. The pectoral is here distinctly divided into its two parts. The anal papilla distant from the anal fin, and prominent. Pigmentation almost as in the stages above described, but the melanophores at the pectoral fin are somewhat more prominent. No photophores indicated.

The metamorphosis stage is of the usual characteristic appearance. We have two typical metamorphosis stages, one of 13.7 mm without caudal, 16.2 with same, and the other 14 mm without and 16.3 with caudal. In these stages, the two caudal melanophores are present, as also the largest one at the base of the pectoral fin, and at posterior margin of the anal, all very distinct. One specimen has all, the other nearly all photophores indicated. EMERY's figure gives the impression that this species also has a large number of the photophores indicated before metamorphosis sets in (cf. the next following species). The two metamorphosis stages were taken with 300 m. w. on the winter cruise.

The number of fin rays agrees with that in the specimen of 24 mm above described. Number of vertebræ appears to be abt. 36 (counted in postlarval stages).

Distribution. I have not yet found this species in the material from the Atlantic north of ca. 40° N.; there are postlarvæ from the Bay of Cadiz. The largest specimen known is stated as being abt. 100 mm or a little over; the species seems thus to be considerably larger than the next following.

In the Mediterranean proper, the species belongs, as will be seen from the accompanying chart, more especially to the Tyrrhenian Sea; this agrees, as we have seen, with the records in the literature. It will further be noted that a large number were taken in the very same waters from which EMERY's specimens were derived.

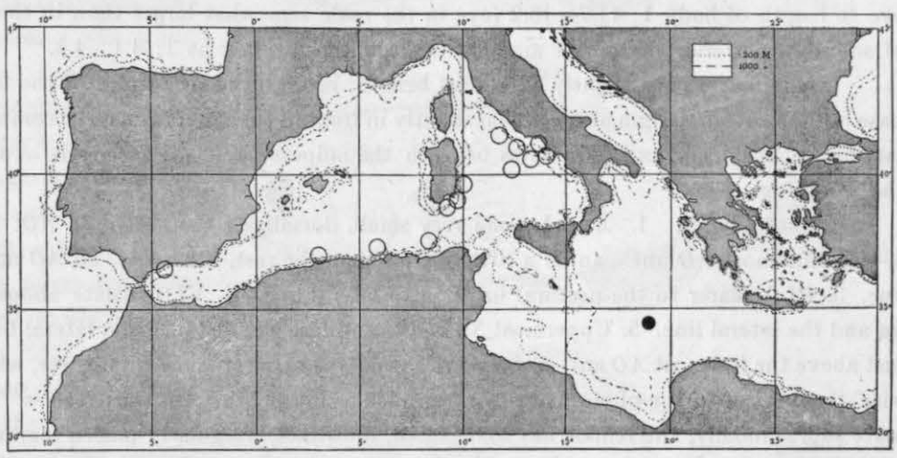

Fig. 28. Distribution of *Diaphus Gemellarii* (Cocco), according to the investigations of the "Thor". ● adult stages, ○ postlarval stages.

The postlarval stages taken number 77 in all (including the two metamorphosis stages); there is also one larger specimen. The greatest number of postlarvæ taken at any station is 15 (St. 26, near the Bay of Naples).

The species is probably found, like the remaining *Scopelids*, only over the greater depths. With regard to vertical distribution, it should be noted that the largest specimen was taken with 300 m. w., and the two metamorphosis stages also with the same length of wire. These last thus seem to keep higher up in the water than the metamorphosis stages generally (cf. the species next following). Postlarvæ were taken with lengths of wire here shown.

Length of wire in metres	Total no. of postl.	No. of hauls
25	23	3
65	18	8
100	5	2
150	9	1
200	5	2
300	13	5
400	1	1
1000	1	1

From this it will be seen that these stages (up to 10—11 mm) belong to the upper 150 metres or so, possibly for the most part to the surface layers.

Propagation. As regards propagation, we can of course say but very little, as large specimens are entirely lacking in the material; such postlarvæ as we have are, however, very instructive in this respect, as will be seen from the figures on next page.

Though fishing was also carried on in the same waters during summer, not a single postlarval stage was taken at that season. The spawning time must thus fall in the winter, and it was at this season, as we have seen, that the metamorphosis stages were found. The specimens mentioned by EMERY were taken at the same time as our present ones (and, as already mentioned, in the same waters: Bay of Naples 10. Feb. 1882). The only larger specimen taken by the "Thor" (24 mm) was caught on the 24. July; the two metamorphosis stages are from 18. Jan. and 10. Feb. In all probability, then individuals ready to spawn would be met with especially in midwinter. MAZZARELLI (1909) states that the species is more particularly found in the Strait of Messina during the months of April—June.

Length in mm	January	February
10—14	4	1
7—10	31	10
< 7	26	5

DIAPHUS DOFLEINI (Zugmayer).

Vert.: 33, *34*, 35; D: 15, *16*. 17; A: 13, *14*; P: 11, *12*; V: 8.

Specific characteristics. Maximal height of body to length of same (without caudal) as 1: 3.7—3.9; minimal height of body to length of body 1: 7.3—7.8; length of head to length of body 1: 3.3—3.5; diameter of eye to length of body 1: 11.7—13.2 (eye in the male somewhat larger than in the female); distance from point of snout to posterior margin of maxillaries to length of body as 1: 4.1—4.4.

Maxillaries only slightly expanded behind; insertion of pectoral low, the fin itself does not reach to the base of the ventral. Origin of the dorsal slightly in front of the ventral, the anal commences just under the posterior margin of the dorsal, and terminates beneath the adipose fin. This species is of shorter and heavier build than the foregoing.

Photophores. 1. *Antorb.*: one very small, dorsally to the nostril. 2. *AO*: 4—6 + 4—6: most frequently 5 + 5; hindmost *AO* ant. can be a little higher than the rest, otherwise, all *AO* ant. and *AO* post. in a straight line. 3. *PLO* nearer to the pectoral fin than to lateral line. 4. *VLO* situate about midway between the ventral fin and the lateral line. 5. Uppermost *SAO*, *Pol* and last *Prc* distant from lateral line. Uppermost *SAO* as a rule just above the foremost *AO* ant. 6. Last *Prc* a good way apart from the first three, which are close together. Otherwise, the position of the photophores is very much as in the other *Diaphus* species. The male has a large luminous plate supracaudally, the female has some small, indistinct, irregularly placed luminous plates infracaudally. The eye is, as mentioned, in mature specimens, smaller in the female than in the male[1]).

Measurements of two specimens (St. 113 and St. 108).

	♀	♂
Total length (excl. caudal)	39	35
Maximal height	10	9
Minimal —	5	4.5
Length of head	12	10
Diameter of eye	3	3
Point of snout to posterior margin of jaw	9	8
Point of snout to dorsal	16	15
Length of dorsal	9	8
Point of snout to anal	25	22
Length of anal	5	5.5
Point of snout to adipose	29.5	26

Material. We have 1409 specimens of this species from the Mediterranean, comprising 691 postlarval stages, and 718 adults. The great majority were taken by the "Thor", only 6 adults by the "Pangan" (St. 276,

[1] Cf. for instance *Lampanyctus alatus* in this respect.

April 1911) and one postlarva was picked up on the shore near Messina (March 1911)[1]. From the Atlantic, I had a comparatively large material of this species.

Literature. This species was described by ZUGMAYER (1911) under the name *Lampanyctus Dofleini*. ZUGMAYER himself lays stress on the secondary sexual characters, and these show beyond question that it is certainly not a *Lampanyctus* species. It will also be seen from the present work that the species must be referred to the *Diaphus* group, together with the foregoing, which likewise differs somewhat from the remaining species of this group. ZUGMAYER's text and figures of this and *Diaphus Gemellarii*, by the way, do not quite agree; I presume, however, that the two species mentioned by ZUGMAYER under the names of *M.* (*Lampanyctus*) *Dofleini* and *M.* (*Diaphus*) *Gemellari* will prove to be one and the same species. I would point out that the characteristic photophores, *AO* and *Prc*, in the two figures given (fig. 8 and 9, Pl. I) are in like position; that the male in this species has a larger eye than the female, and that *Scopelid* species in the Atlantic are often found to be darker than the corresponding forms from the Mediterranean. BRAUER (1906) shows a specimen of this species (fig. 131, p. 213) under the name of *M.* (*Diaphus*) *Gemellari*; FAGE (1910) has the same form under that name, and gives also a fairly good figure of the species (male, Pl. I).

Postlarval characters. *11.5 mm* (13.5 with caudal). This stage, which comes immediately before the metamorphosis, may be characterised as follows. Shape short and thick. Pectoral large, rays of the upper part somewhat prolonged[2]); the rays number apparently about 18, (see below); ventral distinctly formed; anal and dorsal have, like the pectoral and ventral, their rays distinctly formed, but not quite full length; incurvation of the caudal nearly as in the older stages, but a little smaller.

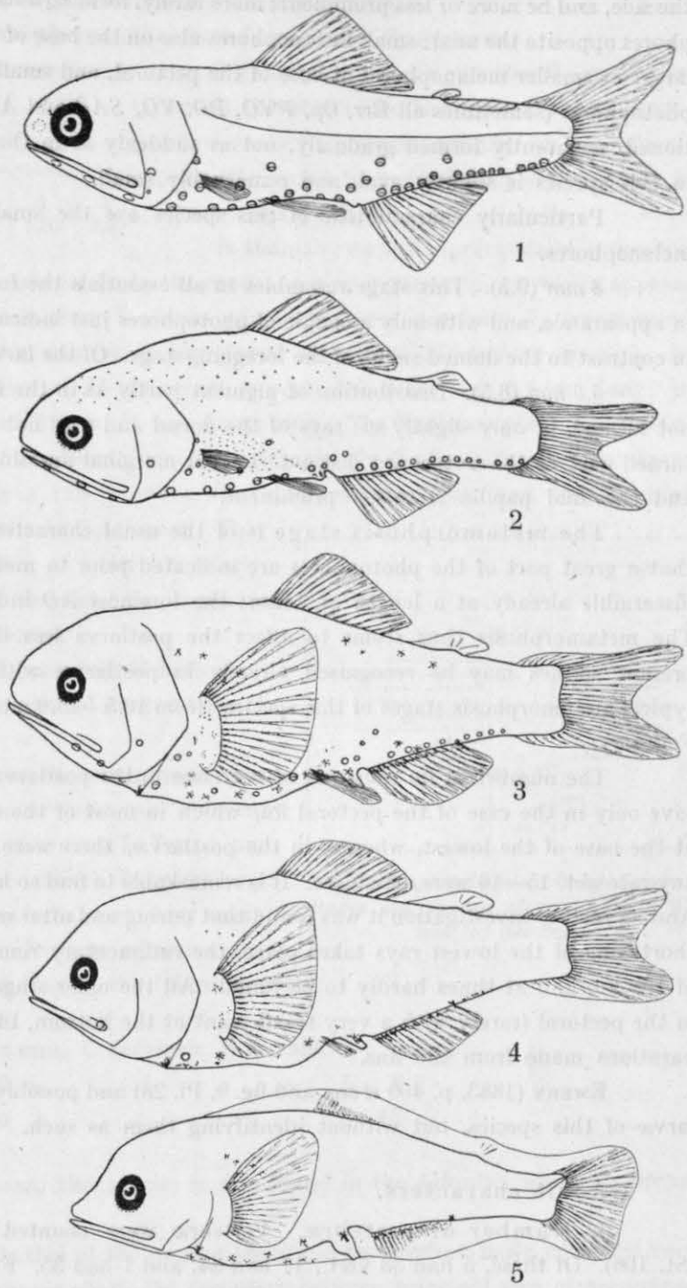

Fig. 29. *Diaphus Dofleini* (Zugmayer). 1: ad. ♂; 2: metamorphosis stage 11 mm; 3: 11.5 mm; 4: 8 mm; 5: 5.5 mm.

Præanal pigment in the form of several scattered melanophores; there are melanophores on the sides of the anal papilla; small melanophores on the point of the clavicles and in front of same. Dorsal pigment apparent

[1] In the material from LÜTKEN's time, preserved in the Zoological Museum at Copenhagen, there are also some postlarvæ of this species, likewise from Messina.

[2] As the pectoral fin is always somewhat damaged, it is difficult so see the connection between the prolonged rays and the shorter ones following; possibly my figure is not quite correct in this respect.

as small scattered melanophores below the dorsal. Melanophores above the pectoral; the last may reach down the side, and be more or less prominent; more rarely, forming a darker part. Ventral pigment in a couple of melanophores opposite the anal; small melanophores also on the base of the same, the hindmost especially strong. Several larger or smaller melanophores at base of the pectoral, and small ones along its rays; also on the ventral. Several photophores (sometimes all *Brr*, *Op*, *PVO*, *PO*, *VO*, *SAO* and *AO*); the photophores in this group being, as mentioned, apparently formed gradually, not as suddenly as in the *Myctophum* and *Lampanyctus* groups. The eye in this species is slightly oval, and remarkably small.

Particularly characteristic of this species are the small eye and the small, highly branched scattered melanophores.

8 mm (9.5). This stage resembles in all essentials the foregoing, though naturally somewhat more larval in appearance, and with only a couple of photophores just indicated (*Brr* and foremost *PO*). The snout somewhat in contrast to the domed snout of the foregoing stage. Of the larval marginal fin-fold little or nothing now present.

5.5 mm (6.5). Distribution of pigment partly as in the foregoing; no indication of photophores. Ventral not formed, or only slightly so; rays of the dorsal and anal not fully formed, farther advanced in the anal. Upturned part of the notochord distinct. Larval marginal fin-fold present. The intestine makes a fairly big curve, and the anal papilla is rather prominent.

The metamorphosis stage is of the usual characteristic appearance. It should be noted, however, that a great part of the photophores are indicated prior to metamorphosis (indication of foremost *PO* at times discernible already at a length of 7 mm; the foremost *AO* indicated at abt. 10 mm, rarely at abt. 8—9 mm). The metamorphosis thus seems to affect the postlarva less than is the case with most other species. The present species may be recognised already in postlarvæ with photophores partially indicated. We have 8 typical metamorphosis stages of this species (from 10.5—13.0 mm), of which seven are from June, and one from February.

The number of fin rays and of vertebræ in the postlarvæ was found to agree with the values for adults, save only in the case of the pectoral fin, which in most of the adults had 11—12 rays, often with a short point at the base of the lowest, whereas in the postlarvæ, there were as a rule abt. 17—19 pectoral rays, of which at any rate abt. 15—16 were articulate. It is remarkable to find so high a number of rays in the pectoral of a *Scopelid*. And on further investigation it was found that during and after metamorphosis (in the adolescent stages) a marked shortening of the lowest rays takes place, the rudimentary remains being then only discernible in preparations of the fin, and at times hardly to be found. All the older stages have thus only 11—12 rays externally visible in the pectoral (rarely with a very small point at the bottom, like a 13th ray). The process can be traced in preparations made from the fins.

Emery (1883, p. 409 *et seq.* and fig. 9, Pl. 28) and possibly also Fage (1910, p. 14, fig. 11) have figured postlarvæ of this species, but without identifying them as such.

Adult characters.

1. Number of vertebræ. Vertebræ were counted in 23 specimens, all from the Alboran Sea (St. 106). Of these, 5 had 33 vert., 17 had 34, and 1 had 35. From the Atlantic also, countings were made with 23 specimens, which exhibited the same distribution as the Mediterranean specimens with regard to this feature (see Introduction p. 23).

2. Number of photophores etc. The photophores were counted in 200 individuals; the number and combinations found are shown in the table below. It will be noticed that 5 + 5 is by far the predominant value for *AO* (differing from the number in the foregoing species: cf. literature on the subject). The specimens in which the photophores were counted were almost exclusively from the principal area of distribution of the species; there does not appear to be any difference between the value here and farther to the east. I may further mention that the various combinations have been found on investigation to be of equally frequent occurrence in both sexes.

Of the 200 specimens examined, 26, or 13%, exhibited difference in number or position of *AO* on right and left sides. In a single specimen, 4 *SAO* were found, the middle one being double.

3. Infra- and supracaudal luminous plates (the secondary sexual characters).

Total No. of *AO*	9		10			11	
AO ant. + *AO* post. ...	4+5	5+4	4+6	5+5	6+4	5+6	6+5
No. of specimens	10	14	8	151	6	4	7
Percentage	5.00	7.00	4.00	75.50	3.00	2.00	3.50

Maculæ anales ant. or post.	4	5	6
anteriores	18	169	13
posteriores	20	168	12

This species has, as mentioned, secondary sexual characters like the species of the *Myctophum* group (in a single instance, an adult specimen was found to have no plates developed; it proved to be a male.)

In the male, we find supracaudally, extending from the adipose fin to the caudal, a long luminous plate, which appears to originate from 5—7, in adult specimens generally 7, transformed scales (this number is also found in several *Myctophum* species). In a specimen of 37 mm (excl. caudal) the plate was 6.5 mm long; in another of 32 mm, it was 5 mm long. The luminous plate can be discerned in many individuals down to 21 mm. In the female, we find infracaudally 2—7 small raised, luminous plates, often somewhat indistinct; they lie as a rule between the hindmost *AO* post. and the foremost *Prc*, extending at times some way in between the last *AO* post. They may be serially arranged, or in a stellate figure, or quite irregularly, extending over only 2 mm at the outside. In females, the luminous plates are first apparent in specimens of abt. 25 mm.

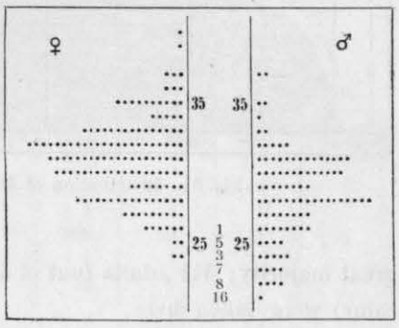

Fig. 30. *Diaphus Dofleini.* Graph showing length and number of specimens of ♀♀ and ♂♂ (see text).

I have here shown in graphical form the numbers of both sexes in this species which had formed their secondary sexual characters, (cf. *Myctophum glaciale* p. 37—38).

It will be noticed that the females are on the whole larger than the males, and also, in the present material, more numerous. We can also see at what size the secondary sexual characters may be found, and at what size they always are found (for exception see above). In a very large number of cases I have satisfied myself that the external secondary sexual characters were in agreement with the presence of ovaria or testes.

The caudal fin appears to increase according to the following scale:

In specimens from 10—20 mm, C increases from abt. 2— 5 mm
— — 20—30 - — — 5— 8 -
— — 30--40 - — — 8—10 -

Distribution. Besides the Mediterranean, this species is also found in the Atlantic, where its occurrence calls for further investigation.

As regards the Mediterranean, the distribution of the present species in the western basin coincides very closely with that of *M. glaciale.* In the accompanying chart, the boundary between principal area of occurrence and the eastern area is indicated by a dotted line.

The following figures will also serve to show the manner of distribution:

			Total no.
Winter cruise	Principal area..	ad.	177
		postl.	298
	Eastern area...	ad.	7
		postl.	15
Summer cruise	Principal area..	ad.	472
		postl.	344
	Eastern area...	ad.	56
		postl.	33

I may further add, that east of Messina, only 17 adult stages were taken (11—37 mm) and 10 postlarvæ. East of the principal area, the adults numbered altogether not over 9 pr. station, the postlarvæ not over 5 pr. station. Furthermore, the Alboran Sea is here, as in the case of *Myctophum glaciale* and other species, the haunt of the

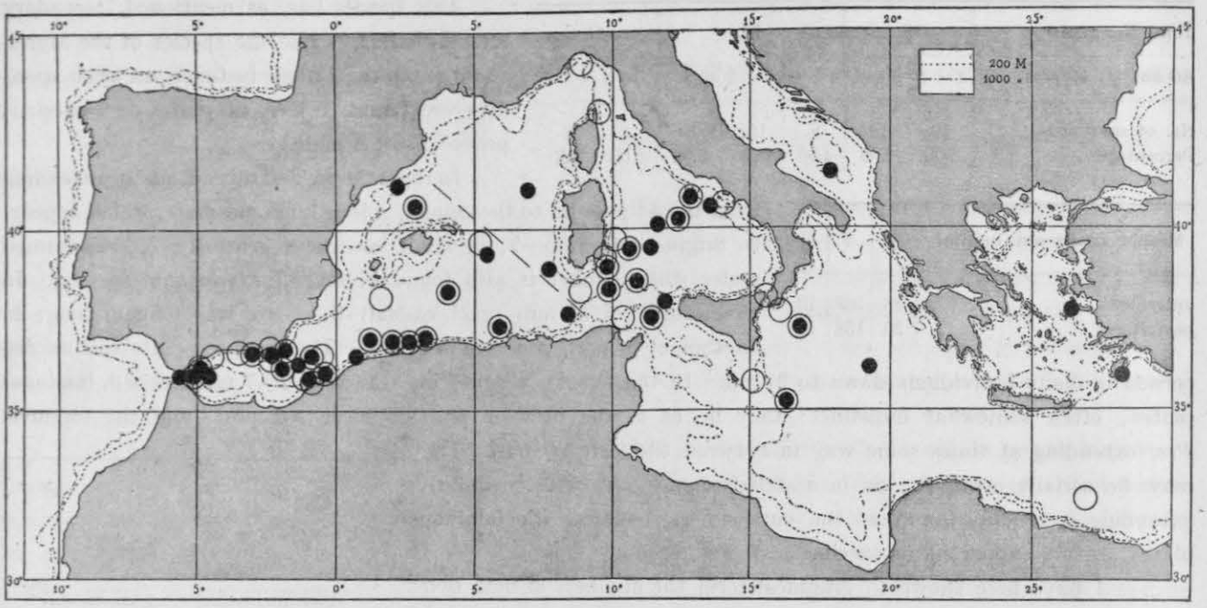

Fig. 31. Distribution of *Diaphus Dofleini* (Zugmayer), according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

great majority; 441 adults (out of a total of 649 from the main area) and 554 postlarvæ (out of 642 from the same) were taken here.

Among the richest stations, the following may be mentioned:

	Adult stages:		Postlarval stages:	
Alboran Sea:	St. 50.....	113 spec.	St. 57.....	213 spec.
	- 99.....	43 -	- 107.....	91 -
	- 220.....	145 -		
	- 223.....	56 -		
Coast of Algeria	- 46.....	26 -	- 47.....	26 -

The species is found chiefly over the greatest depths, especially beyond the 500 metre limit, though this applies more particularly to the adult stages, and less to the postlarvæ.

Soundings in metres	Total no. of Stations	Adults		Postlarvæ	
		Pos. st.	No. of sp.	Pos. st.	No. of sp.
0—100	18	0	0	4	38
100—500	19	2	148	6	275
500—1000	25	11	153	9	42
1000—2000	29	10	102	7	61
>2000	40	19	309	19	271

In connection with the accompanying table it should be noted that out of the 148 adult stages found inside the 500 m limit, 145 were taken at a single station (St. 220, the specimens being 11—21 mm) and that 247 of the postlarval stages taken within the same limit are from stations in the northern part of the Alboran Sea in winter, (St. 55, 57 and 58 — cf. *M. glaciale* p. 40).

The vertical distribution of the adult stages will be seen from the table on p. 81.

We notice here, that this species, like the rest, is found higher up in winter than in summer (June), while September appears to occupy an intermediate position (the great bulk of the material was taken in June and September, in the principal area of occurrence).

It will now be interesting to rearrange the figures from this table, and see, firstly where the specimens are to be found when ready to spawn, and secondly, where the smallest adolescent stages are taken. This is shown in the table below.

Metres of wire out	Winter		Summer			
	February		June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	47	94	8	4	175	70
65	57	13	17	10	0	0
300	19	8	164	27	116	33
1000—2000	10	2	32	5	8	2

It is at once seen that the smallest adult stages occur in almost the same water layers as the mature fish, which are taken for the most part with 25—300 m. w., deepest down in June. It might be expected that this species, of which we have so large a material, would exhibit the same marked peculiarity as several others in respect of ontogenetic migration, which, however, does not appear altogether to be the case; this is perhaps in relation with the fact that the photophores in this (as also in nearly related forms) are not developed so suddenly as in most other species. Possibly then, the postlarvæ of this species do not descend

Metres of wire out	10—19 mm						25—34 mm					
	Dec.—Feb.		June—July		Aug.—Sept.		Dec.—Feb.		June—July		Aug.—Sept.	
	No. of spec.	No of pos. hauls	No. of spec.	No. of pos. hauls	No. of spec.	No. of pos. hauls	No. of spec.	No. of pos. hauls	No. of spec.	No. of pos. hauls	No. of spec.	No. of pos. hauls
25	32	1	8	5	150	7	5	1	..	..	18	1
65	31	3	13	4	..	..	16	1	1	1		
300	17	3	31	8	64	8	2	2	108	10	31	6
500—800	3	2	1	1	2	1	7	4	2	1		
1000—2000	2	1	12	4	5	3	2	2	16	6	1	1

to so great depths as others during metamorphosis, or perhaps, the metamorphosis itself does not take so long, and they are sooner able to seek those levels at which they live during their adult stages, (the metamorphosis stage was taken deep down (7 specimens) but also with 300 m. w. (1 specimen, in winter)).

The largest postlarval stages (10—13 mm) were taken at the different depths as shown; the figures seem to suggest a certain downward trend (cf. the table next following).

Metres of wire out	No. of spec. (10—13 mm)	Percentage
25	0	0
65	10	33
300	8	27
> 300	12	40

Altogether, 39 specimens were taken with over 300 m. w., or only abt. 6 % of the total postlarval material; of the largest, then, a comparatively high proportion are from deep water.

The vertical distribution of the postlarval stages is as generally found in postlarvæ of *Scopelids*, as will be seen from the following table:

Metres of wire out	Dec.—Feb.		June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	210	105	1	2	5	5
65	35	4	208	83	0	0
300	39	13	79	13	39	13

At depths beyond 300 m. w. only 39 specimens were taken, as mentioned; of these, abt. 1/3 were over 10 mm, the greater part of the remainder were possibly taken while hauling in the net. The postlarvæ thus belong chiefly to the upper 150 m water layers. Before the approach of metamorphosis, there does not appear to be any difference in the depth at which the different stages are found, nor do they appear to make any vertical day-to-night migration; at any rate, the present material tells us nothing as to this.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	April 1911	June 1910	July 1910	Aug. 1910	Sept. 1910
40	..	..	..	..	1			
	..	..	..	..	1			
	1	..	..	..	3	1		
	..	..	..	..	2	..	..	1
35	..	..	..	..	9	2	1	
	..	..	2	..	5			
	..	..	1	..	14	1	..	1
	..	2	..	..	16	..	..	10
	..	..	4	..	23	1	..	7
30	..	..	3	..	24	..	..	7
	1	..	3	..	9	1	..	4
	..	..	11	..	9	5	..	9
	..	..	9	..	6	2	..	3
	..	..	3	..	3	3	..	6
25	..	..	3	..	3	2	2	1
	..	..	1	..	3	..	..	6
	..	..	4	..	2	1	2	2
	..	1	4	..	4	..	..	3
	1	..	8	..	1	..	1	6
20	..	..	6	..	4	..	..	10
	..	..	6	..	4	1	..	5
	..	..	10	..	3	..	1	16
	..	..	6	..	6	2	1	17
	..	..	18	..	4	3	..	29
15	..	..	12	1	2	4	1	27
	..	..	18	2	8	7	1	34
	..	..	12	3	7	5	1	49
	1	..	20	..	5	2	1	29
	..	..	8	..	1	1	4	4
10	..	..	5					

As regards day-to-night migrations of the adult stages, the following should be noted:

of 667 specimens taken in 58 night hauls, 40 were taken with over 500 m. w. (in 14 hauls).

of 27 specimens taken in 9 day hauls, 26 were taken with over 500 m. w. (in 8 hauls).

Three day hauls were made in winter with less than 500 m. w. at stations where any catch of the species was made at all; of these, one gave positive result, (a specimen 21 mm long, taken with 65 m.w.); in summer, six day hauls were made at stations where the species was found at all, but without results. Of the 26 specimens taken in day hauls with over 500 m. w., 9 were under 15 mm, and 13 over 25 mm. By far the greater number were taken, as in the case of all species, in night hauls. This tells us nothing definite as to day-and-night migrations, since the few specimens taken in day hauls at greater depths either belong there (the smallest) or might have been taken while hauling up the net, or were perhaps all taken at the depth indicated, and might then either really have moved down to there, or merely represent the species in its lower boundary area, and were caught through not being able to elude the nets in the faint light prevailing at the depth in question. Thus, as we see, nothing definite can be said on this point. The specimens taken in day hauls are so few that no conclusions can be based on such small numbers.

Propagation. This species is evidently one of the smaller forms, as in the first place, the postlarvæ are small at the time of metamorphosis, and in addition, no specimens over 40 mm were taken by the expedition. Like *M. glaciale*, for instance, it appears to be represented in our material only by the 0- and I-groups, as will be seen from the graph (fig. 32) and table for catch at different seasons.

Spawning appears to take place from winter to some way on in summer, though a certain amount of spawning doubtless occurs all the year round, as the tables on this and the next page seem to suggest.

It is worth noting that in certain biological features, the present species exhibits a considerable resemblance to *M. glaciale.*

Maturity is attained at a length of about 30 mm.

The largest ovaries were found in a specimen of 40 mm; and measured here abt. 10 mm in length, by abt. 2.5 in breadth. As a rule, the ovaries were abt. 8—9 mm long.

The largest eggs which were still opaque had a

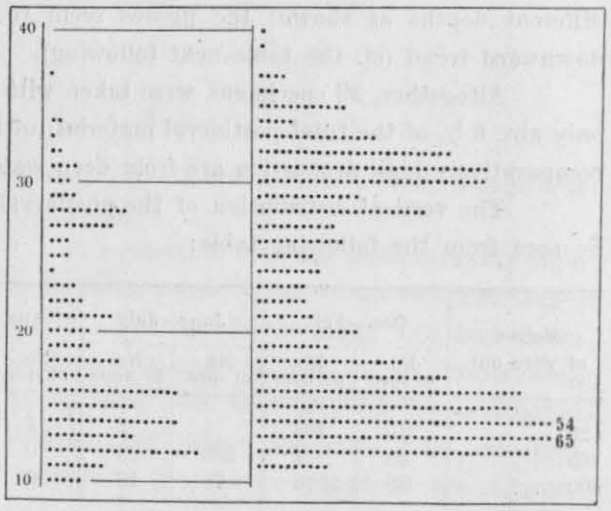

Fig. 32. *Diaphus Dofleini.* Length in mm of specimens from the winter cruise (first column) and the summer cruise (second column).

maximal diameter of 0.48 mm; in one specimen, 155 of the eggs (out of a total 363 large) were larger and more transparent, evidently just ready for spawning. The largest transparent eggs were 0,75 mm, the smallest opaque eggs 0.45 mm diameter.

Month	No. of postlarvæ	No. pr. hour
February	304	30
June	298	35
September	40	11

Size in mm	February		June		September	
	No. of sp.	%	No. of sp.	%	No. of sp.	%
10—13	2	0.7	23	7.7	3	7.5
7— 9	86	28.3	188	63.1	30	75.0
<7	216	71.0	87	29.2	7	17.5

The following numbers of large eggs were counted in the ovaries:

Length of fish (excl. caudal):	No. of large eggs
31 mm (June)	(196 + 167) = 363.
32 - (September)	(152 + 178) = 330.
33 - (June)	(205 + 171) = 376.
40 - (June)	(226 + 258) = 484.

DIAPHUS RAFINESQUEI (Cocco).

Vert.: 33, *34*; D: 12, *13*; A: 13, *14*; P: 9, *10*, 11; V: 8.

Specific characteristics. Maximal height to total length (excl. C.) 1: 3.9—4.1; minimal height to total length 1: 8.0—8.2; length of head to total length 1: 3.3—3.4; diameter of eye to total length 1: 8.9—9.3; distance from point of snout to posterior margin of jaw to total length 1: 4.7—5.1. Maxillaries only slightly expanded behind. Insertion of pectoral very low, the fin itself reaches to the base of the ventral. Dorsal commences almost immediately above the ventral; the anal commences shortly behind the posterior margin of the dorsal, and terminates just under the adipose fin. Slenderer than *Diaphus Holti*.

Photophores. 1. *Antorb.*: one medium size dorsally to nostril, separated by an interval from that on the other side. *Suborb.*: two, one long and fairly narrow in front, and a small round one behind, this being, however, in close connection with the posterior end of the foremost one. These photophores are somewhat smaller than in the species next following. (The suborbital organ, by the way, seems to be a little larger (broader) in the male than in the female, as far as can be seen from the few large specimens available). (See fig. 25, 1, p. 72). 2. *AO*: 5—7 + 3—5, as a rule 6 + 4; the anterior and posterior *AO* ant. always higher than the rest, so that *AO* ant. form an arch, and the hindmost *AO* ant. may appear like an extra *Pol*; *AO* post. lie in a straight line; the last can, where there are 5, be somewhat smaller than the rest. 3. *PLO* nearer to the pectoral than to the lateral line, and with a large luminous scale below and behind. 4. *VLO* situate about midway between the lateral line and the ventral fin. 5. *SAO* in a fairly steep line, running out to the fore half of the interval between dorsal and adipose fins. Uppermost *SAO*, *Pol* and last *Prc* are only a little way distant from the lateral line.

Otherwise, the position of the photophores is practically the same as in the other *Diaphus* species.

Measurements of two specimens (St. 42):

	♀	♂
Total length (excl. caudal)	56 mm	49 mm
Maximal height	14 -	12 -
Minimal —	7 -	6 -
Length of head	16.5 -	15 -
Diameter of eye	6 -	5.5 -

	♀	♂
Point of snout to posterior margin of jaw	11 mm	10 mm
Point of snout to dorsal	26 -	22.5 -
Length of dorsal	9 -	8.5 -
Point of snout to anal	37 -	32 -
Length of anal	8 -	7 -
Point of snout to adipose	45 -	39 -

Material: We have 123 specimens of this species from the Mediterranean. Of these, 28 are postlarval stages, and 95 adults. The entire material was taken by the "Thor". I have also had some specimens of this species from the Atlantic.

Literature. The species was described by Cocco from the Mediterranean in 1838. It has, however, not been separated from the next following species until now, the two having previously been treated together; both are found at Messina, from which most of the material was derived. I have been able to satisfy myself as to this by going through LÜTKEN's material, in which specimens of both forms are found together from Messina

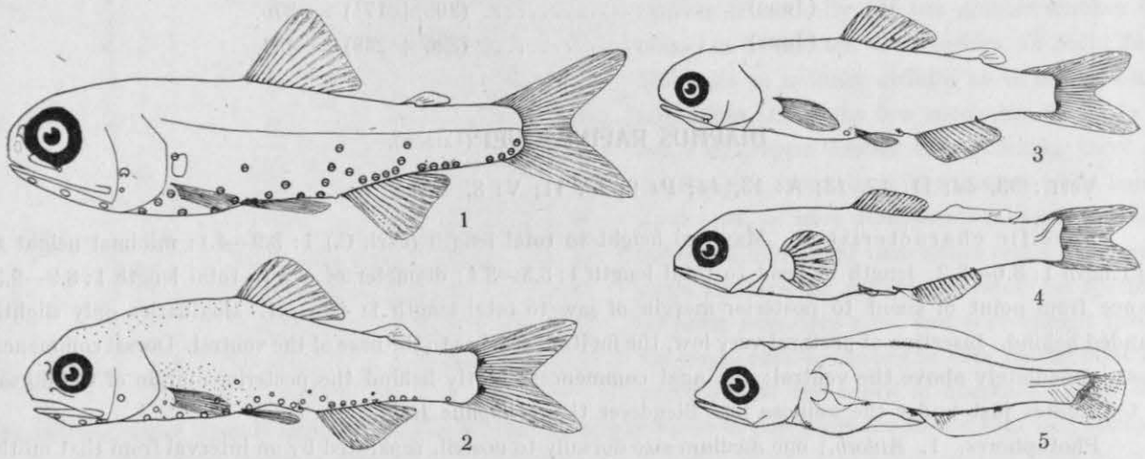

Fig. 33. *Diaphus Rafinesquei* (Cocco). 1: ad.; 2: metamorphosis stage 10 mm; 3: 9.5 mm; 4: 6 mm; 5: 4.5 mm.

(signed DODERLEIN, BELLOTTI, GIGLIOLI). It is not always possible, however, to determine from the records in literature which of the two species is meant in each case, but I consider it fairly certain that the following writers have really had specimens of the present species on which to base their descriptions: Cocco (1838)[1]), BONAPARTE (1832—41), LEYDIG (1881 — fig. 54 pl. X), RAFFAELE (1889—91), MOREAU (1891), LÜTKEN (1892: sketch p. 234), BRAUER (1906), HOLT and BYRNE (1911), and MURRAY and HJORT (1912).

Postlarval characters.

9.5 mm (11.5 with caudal). This stage, which comes immediately before the metamorphosis, may be characterised as follows. Shape slender. Fins with all rays distinctly formed, though not yet of the length and shape found in the adult stages (this applies especially to the pectoral and the caudal). Eye circular. Præanal pigment: a faint melanophore on the side of the anal papilla; more rarely, internal pigment farther forward, e. g. at root of the ventral. Ventral pigment: one strong melanophore at posterior margin of anal (no row of melanophores along anal and between same and the caudal, as in the following species). On the caudal fin, at its base, are two strong melanophores, one on the upper and one on the lower half (cf. *Diaphus Gemellarii*). Of photophores, indications of *Brr* and hindmost *PO*. Particularly characteristic are the two caudal melanophores and the one ventral.

6 mm (7.2). Pigmentation as the foregoing. Remains of the larval marginal fin-fold. Fin rays very nearly

[1] See Fig. 26.

formed, but short. No indication of photophores; such may be indicated at a length of abt. 7 mm, (*Brr* and hindmost *PO*). Upturned portion of the notochord just discernible. Intestine forms a gentle curve.

4.5 mm. Distribution of pigment as in the foregoing; the melanophores somewhat more distinctly prominent. Larval marginal fin-fold intact; of the dorsal, only the base is faintly indicated; the anal a little more. Rays of the caudal just discernible, as also some of those in the pectoral. The tip of the notochord is slightly bent. Intestine forms a big curve.

Metamorphosis stage is of the usual characteristic appearance. Diffuse pigment dorsally, and on the sides of the forepart of the body. Remains of postlarval pigment (of the specially characteristic melanophores). The typical metamorphosis stage is represented by only one specimen 10 mm long, with most of the photophores indicated. The metamorphosis stage in this species seems to be somewhat smaller than in the next following (see below). The characteristic postlarval melanophores can be observed in most of the smaller adolescent stages. The metamorphosis stage was taken on the winter cruise with 1200 m. w.

Number of fin rays was investigated in postlarval stages, and found to be in accordance with that found in the oldest stages. No description or illustration of this postlarva has, as far as I am aware, been published up to now.

Adult characters.

1. Number of vertebræ. Vertebræ were counted in 22 specimens of this species; of these, 19 had 34, and 3 had 33, (there is thus a distinct difference in this respect between the present species and that next following). Eleven specimens were from the Ionian Sea (St. 11); of these, 9 had 34 vertebræ, and 2 had 33; the remainder were from various stations in the Tyrrhenian and Balearic Seas. From the Atlantic, 8 specimens were examined for no. of vert., in most cases 34 were found, in a single instance 35.

Total no. of *AO*	9		10			11
AO ant. + *AO* post. ...	5 + 4	6 + 3	5 + 5	6 + 4	7 + 3	6 + 5
No. of specimens	1	2	5	83	1	1
Percentage	1.08	2.15	5.38	89.23	1.08	1.08

Maculæ anales ant. or post. ..	3	4	5	6	7
anteriores	..	..	6	86	1
posteriores	3	84	6		

2. No. of photophores etc. The maculæ anales were counted in 93 specimens; the various combinations of *AO* ant. and *AO* post. will be seen from the table. (In this character also, a distinct difference is discernible between the present species and that next following).

Length of the caudal cannot be determined in the case of the larger specimens, as the fin is always destroyed in the nets. Individuals of 11—14 mm had caudal fin measuring abt. 2—3 mm.

Distribution. *Diaphus Rafinesquei* is found, besides in the Mediterranean, also in the Atlantic, as evident from the material at my disposal, and also from the literature above quoted. Its occurrence in the Mediterranean will be seen from the accompanying chart and the following figures:

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Adriatic Sea	Levantine Sea
Adults	0	15	38	37	2	2
Postlarvæ	0	7	2	19	0	0

It will be noticed that the principal area of occurrence lies in the waters near the coasts of Italy. Some are said to have been taken from time to time in the Strait of Messina. The few postlarval stages taken are from the waters where most adult forms were found.

St. 10 (Ionian Sea) .... 11 postlarval stages.
- 11 — — .... 18 adult stages.
- 13 — — .... 10 — —
- 26 (Tyrrhenian Sea) ... 10 — —

Among the richer stations, the following may be mentioned.

The species is found, like the other *Scopelids*, over great depths.

As regards vertical distribution of the adults and postlarval stages, the present small amount of material can naturally tell us but little.

From the table below it would seem that the adult stages of this species live deeper down than many other *Scopelids;* some individuals seem, however, to keep higher up than others, these being nearly always

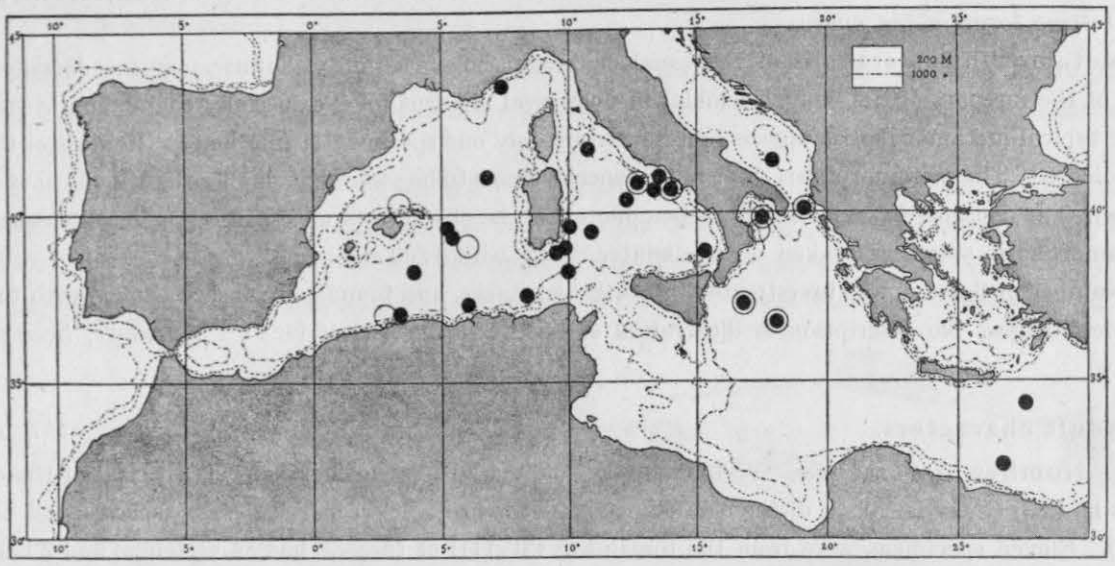

Fig. 34. Distribution of *Diaphus Rafinesquei* (Cocco), according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

smaller specimens, under 20 mm, but a specimen of 28 mm was taken in summer with 65 m. w. The postlarvæ are apparently found only in the surface layers; not until metamorphosis sets in do they move down; the one specimen taken at a great depth was also a typical metamorphosis stage.

Metres of wire out	Postlarval stages				Adult stages			
	Winter		Summer		Winter		Summer	
	No. of spec.	Positive hauls	No. of spec.	Positive hauls	No. of spec.	Positive hauls	No. of spec.	Positive hauls
25	3	2	7	3	1	1		
65	15	5	..	..	5	2	1	1
100—150	1	1	..	..	1	1		
200	1	1	..	..	14	4		
300	..	..	..	..	37	7	6	6
400	..	..	..	..	3	1		
600—700	..	..	..	..	6	2	1	1
1000	..	..	..	..	9	5	2	2
1200—1600 ...	1	1	..	..	6	3		
2000	..	..	..	..	..	..	1	1

The following figures will show where the largest specimens (over 30 mm) were taken:

Length of wire in metres	No. of spec. > 30 mm	No. of hauls
300	8	6
600	1	1
1000	2	2
2000	1	1

Most of these were taken in night hauls; two, however, (54—56 mm) between 7 and 9 a. m. on the 16th Dec. 1908 with 300 m. w.

From this it would seem pretty evident that the mature or nearly mature individuals are deeper-living fish, which do not seem to swim in shoals.

No distinct day-to-night migration is evident from the material; in day hauls, 15 specimens were taken with 300 m. w. and 14 with over 500 m. w.; none were taken in day hauls with 25-200 m. w.; those taken with these lengths (22 individuals) were taken at night.

The smallest adolescent stages under 15 mm were only taken in winter; these also appear to be found for the most part in the deeper layers. The deeper occurrence of the stages near metamorphosis is hardly so markedly

prominent in the case of this species; possibly the reason is here, as in the case of *Diaphus Dofleini*, for instance, that the ontogenetic migration itself is less typically apparent than in certain *Myctophum* species, and this would seem to have some connection with the formation of the photophores. It may, however, also be merely due to paucity of material. As mentioned above, we have a typical metamorphosis stage from greater depth, and it will be seen from the following figures that the adolescent stages are found farther down than the postlarvæ — which agrees with the manner of life among the older fish.

Length of wire in metres	No. of spec. < 15 mm	No. of hauls
25—65	6	3
300	29	6
> 300	20	9

Propagation. Only 28 postlarvæ of this species were found, and of these 21 were taken in December—January, and 7 about 1. Sept. The sizes were as follows:

Size in mm	Winter cruise	Summer cruise
> 10	1	—
7—10	14	—
< 7	6	7

On comparison with the lengths and number of the different specimens in the different months, as given here, it certainly seems as if the species must spawn in autumn and winter; it would be very remarkable that the "Thor" should not have taken more than these 7 postlarvæ in summer if there really were more to be found. In any case, fishing was carried out both summer and winter in parts of the principal area of distribution. It will be noticed that the 7 specimens taken abt. 1. Sept. are themselves quite small, which might seem to suggest that at the time when the "Thor" left the Mediterranean, in the autumn, these small stages were only just beginning to appear. This species, then, seems to have a very restricted spawning time (cf. the species next following, and *Lampanyctus maderensis*.)

Maturity seems first to occur after the fish has reached a length of 50 mm, but this question needs further investigation, as the present material is too small to judge by. I would here also point out that this species evidently belongs to the larger forms, but has nevertheless its metamorphosis at a stage of no great size.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	June 1910	July 1910	Aug. 1910
65	..	..	..	..	..	1
60	..	..	1			
	1					
55	1					
50	..	..	1			
45	..	..	..	..	..	1
40	..	..	..	1		
	..	..	..	..	..	1
35	..	..	..	1	1	
30	..	..	..	1	1	
	..	..	..	1		
25	..	..	..	..	1	
	..	..	..	..	1	
20	..	..	1			
	..	..	1			
	..	1	1			
15	1	..	2			
	1	2	1			
	9	6	1			
	12	18				
	10	8				
10	4	1				

A female of 66 mm had (in August) ovaries abt. 16 mm long and abt. 3.5 mm broad; the eggs were abt. 0.35 mm in diameter and there were abt. 2950 large eggs in both ovaries together.

DIAPHUS HOLTI, sp. nov.

Vert.: 32, *33*, 34; D: *14*, 15; A: *13*, 14; P: 10, *11*, 12; V: 8.

Specific characteristics. Maximal height to total length (excl. C.) 1: 3.6—3.8; minimal height to total length 1: 7.6—8.0; length of head to total length 1: 3.1—3.5; diameter of eye to total length 1: 8.0—8.9; distance from point of snout to posterior margin of jaw to total length 1: 4.4—4.8. Maxillaries but slightly expanded behind. Insertion of pectoral very low, the fin itself reaches to base of the pectoral. Dorsal commences almost exactly above the ventral; anal commences a little behind posterior margin of the dorsal, terminating below the adipose fin. Shorter and heavier build than *Diaphus Rafinesquei*.

Photophores. 1. *Antorb.*: One large, dorsally to the nostril, separated by an interval from that on the other side. *Suborb.*: two, a large broad one in front, and a fairly large round one behind, distinctly separated from the rear end of the foremost. These photophores are slightly larger than in the foregoing species. (See fig. 25, 2, p. 72). 2. *AO*: 4—5 + 3—5; as a rule 5 + 4; foremost *AO* ant. rarely if ever above the rest of the row, and then only slightly so; hindmost *AO* ant. higher than the rest, may appear as an extra *Pol*; *AO* post. in a straight line; where there are 5 *AO* post., the hindmost is often smaller than the rest. 3. *PLO* closer to the pectoral fin than to the lateral line, and with a luminous scale below and behind. 4. *VLO* closer to the ventral fin than to the lateral line. 5. *SAO* in a not very steep line, running out to the posterior half of the interval between dorsal and adipose fins. Uppermost *SAO*, *Pol* and last *Prc* some way apart from the lateral line.

Otherwise, the position of the photophores is very nearly as in other *Diaphus* species.

Measurements of two specimens (St. 113).

	♀	♂
Total length (excl. caudal)	38 mm	36 mm
Maximal height	10 -	9.5 -
Minimal —	5 -	4.7 -
Length of head	11.7 -	11.5 -
Diameter of eye	4.3 -	4.5 -
Point of snout to posterior margin of jaw	8 -	8 -
Point of snout to dorsal	18.5 -	17.5 -
Length of dorsal	7.5 -	7 -
Point of snout to anal	24.5 -	24 -
Length of anal	5 -	4.5 -
Point of snout to adipose	30 -	28 -

Material: Of this species, we have 638 specimens from the Mediterranean, comprising 477 postlarval stages and 161 adults. By far the most of these were taken by the "Thor"; there are, however, two large specimens picked up on the shore near Messina by Capt. G. Hansen 1911. Otherwise, only a few specimens from the Bay of Cadiz; from the Atlantic proper none in my material.

Literature: As mentioned under *Diaphus Rafinesquei*, this species has in earlier works been taken together with the former; there seems, however, to be but little in the literature which can really be referred to the present form; most descriptions of *D. Rafinesquei* give a value for number of fin rays which best fits in with that species (*D. Raf.*). The reason of this is perhaps that *D. Rafinesquei* attains a larger size, and is not so easily damaged as the present form, so that specimens of the former would consequently be selected for preference as subjects for description.

Leydig (1881) shows in fig. 56 Pl. X the head of a specimen of this species under the name of *Scopelus metopoclampus ?;* from the text on p. 62 it is plain that Leydig's specimen was really *Diaphus Holti*. Lütken (1892) has figured this species in fig. 17 p. 259; the identity is further confirmed by the footnote there. As already

mentioned, LÜTKEN's material includes both species; it would seem — in agreement with the general occurrence of the two forms — that the foregoing species is the one more frequently found in the Strait of Messina.

Postlarval characters. *10 mm* (12.25 with caudal). This stage, which comes immediately before metamorphosis, may be characterised as follows. Shape slender. Fins with all rays distinctly formed, but not yet of the length or shape found in the adult fish (pectoral and caudal especially). Eye circular.

Præanal pigment apparent as a partially internal melanophore on the anal papilla; also as a rule a couple of smaller (often internal) melanophores farther forward, e. g. at point of the clavicles. Ventral pigment: a row of melanophores, partly internal. along the base of the anal fin, and between same and the caudal. At the root of the caudal, there is a large melanophore, which is always situate on the lower half of the base; this melanophore can, though rarely, be found secondarily dissolved into two or more, which are then always situate on the lower half of the caudal fin. Of photophores: indications of *Brr*, *PO* No. 1 and 5, the last especially strong.

Particularly characteristic are the caudal spot and the ventral row of melanophores.

6.5 mm (8). Pigmentation at this and intermediate stages the same as in the foregoing. Part of the larval marginal fin-fold present. The ventral fin only slightly indicated. Rays in the dorsal and anal hardly quite formed;

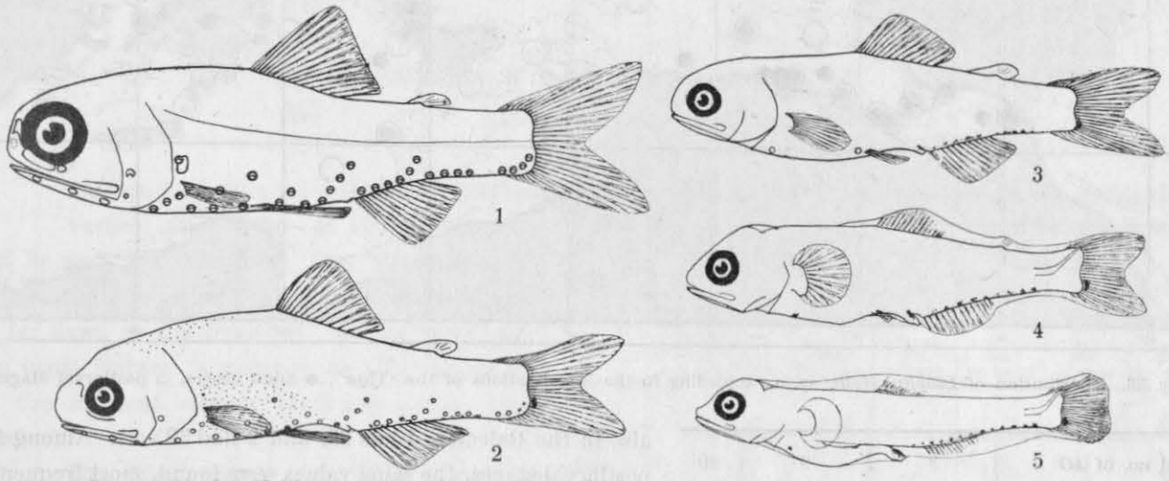

Fig. 35. *Diaphus Holti,* sp. nov. 1: ad.; 2: metamorphosis stage 11.5 mm; 3: 10 mm; 4: 6.5 mm; 5: 5 mm.

those of the anal farthest advanced. No indications of photophores; these are first indicated at abt. 7 mm length (*PO*). The upturned portion of the notochord visible.

5 mm (6). Distribution of pigment about the same as the foregoing, save that the ventral series of melanophores is more prominent, as is the rule with the smallest stages where such melanophores are found. Larval marginal fin-fold intact; dorsal and anal fins not nearly formed, the ventral not indicated, rays of the pectoral not yet formed. Upturned portion of the notochord distinct. The intestine makes a big curve.

The metamorphosis stage is of the usual characteristic appearance. Diffuse pigment dorsally, and on the sides of the forepart of the body. Postlarval pigment: remains both of the ventral row of melanophores and those at base of caudal fin and on anal papilla. Besides most of the photophores, indications of the antorbital and suborbital organs may be observed. Of the typical metamorphosis stages we have 5 (10—12 mm long) with most of the photophores indicated. These stages were taken at great depths. As with other species of the sub-genus *Diaphus*, the photophores are indicated at an early stage, and we may at times find indications of most of them before metamorphosis sets in — (also for instance of the rarely indicated *SAO* and foremost *AO* ant. and post.). Remains of the postlarval pigment may be traced in the adolescent stages up to over 20 mm. The values found for number of fin rays and vertebræ in the postlarval stages were in agreement with those for the oldest stages. I have in a single instance found 34 vertebræ in a postlarval stage, a

figure which I have not met with in any of the adults examined; it is, however, only to be expected that this variate should appear.

As far as I am aware, no description or illustration of this postlarva has hitherto been published.

Adult characters.

1. Number of vertebræ. In this species, vertebræ were counted in 26 adults and a number of postlarvæ. Twenty adults from St. 50 in the Balearic Sea showed without exception 33 vert. Of 6 adults from St. 47,

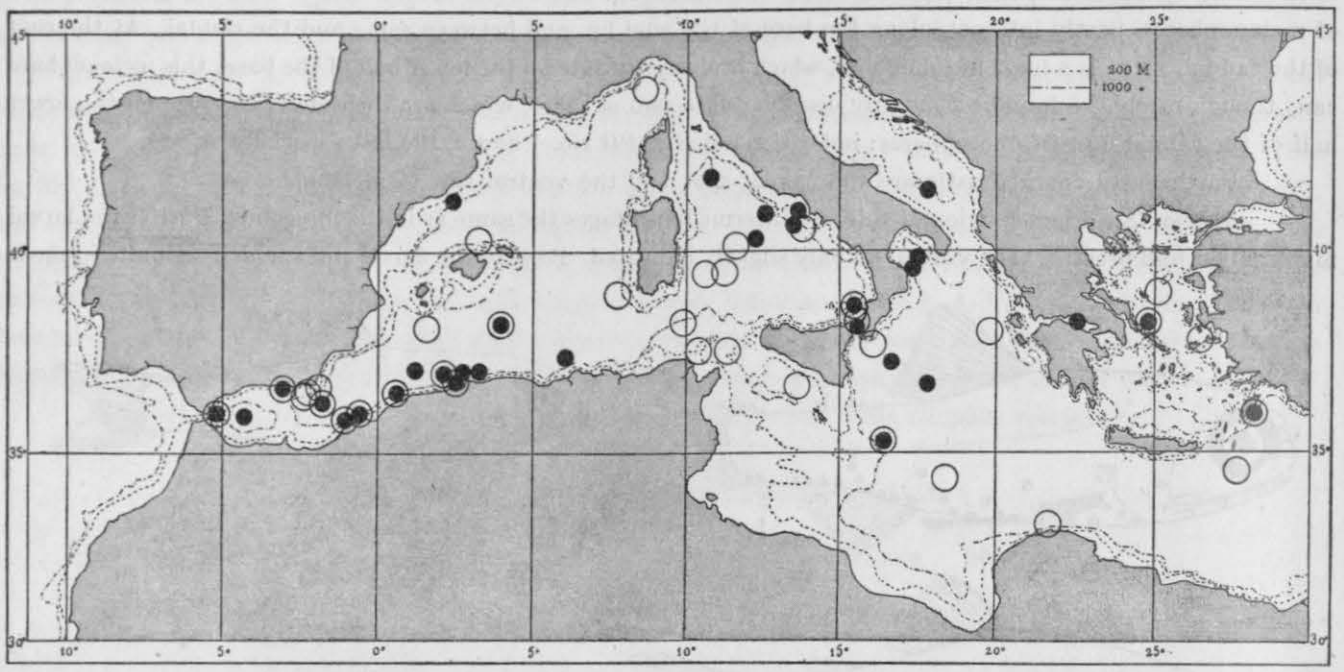

Fig. 36. Distribution of *Diaphus Holti*, sp. n., according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

Total no. of *AO*	8		9		10
AO ant. + *AO* post.	4 + 4	5 + 3	4 + 5	5 + 4	5 + 5
No. of specimens	1	1	3	142	5
Percentage	0.66	0.66	1.97	93.42	3.29

also in the Balearic, 4 had 33, and 2 had 32 vert. Among the postlarval stages, the same values were found, most frequently 33, and in addition, as mentioned above, a single specimen with 34. In number of vertebræ, then, this species differs from the foregoing.

2. No. of photophores etc. Maculæ anales were counted in 152 specimens. The various combinations of *AO* ant. and *AO* post. are shown in the table, which reveals a considerable difference between the present and foregoing species. Where there are 5 *AO* post., the hindmost is, as mentioned, generally smaller than the four in front.

Maculæ anales ant. or post.	3	4	5
anteriores	..	4	148
posteriores	1	143	8

The caudal fin is in this species also often much worn; the length, as far as can be seen, should be as follows:

At a length of abt. 10 mm the caudal fin is abt. 2.5 mm long
— — 20 - — — 5 - —
— — 30 - — — 7 - —
— — 40 - — — 9 - —

Distribution. Up to the present the only finds of *Diaphus Holti* recorded from the Atlantic were made in the Bay of Cadiz; there is, however, hardly any doubt that this species will, like the other *Scopelids* taken in the Mediterranean, also prove to occur in other parts of the Atlantic.

Its distribution in the Mediterranean will be seen from the accompanying chart and table showing catch of adults and postlarval stages in the various parts of that sea.

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Adriatic Sea	Levantine Sea	Ægean Sea
Adults.....	25	94	14	16	8	1	1
Postlarvæ ..	329	96	15	13	0	4	18

A decrease is here noticeable in the numbers from west to east, evidently with some increase again in the Ægean (cf. *Lampanyctus maderensis* in this respect). The principal area seems to lie particularly in the Balearic Sea, along the coast of Algeria, and in the Alboran Sea; i. e. in the waters where the other species were most numerous[1]).

The following rich stations should be noted.

St. 46 (Coast of Algeria in Balearic Sea) 18 adult stages
- 47 — — 11 —
- 50 — — 40 —
- 113 — — 10 —
- 218 — — 72 postlarval stages
- 220 (Alboran Sea) 80 —
- 222 — 116 —
- 225 — 105 —

This species is found, like the rest, for the most part over great depths (from 500—1000 metres and beyond).

Vertical distribution of the adult stages will be seen from the table. The figures seem to suggest that the present species does not live quite so far down as the foregoing. We find, however, the usual feature: occurrence at different depths in the different seasons (February—June—September).

Metres of wire out	Winter		Summer			
	Dec.—Feb.		June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25.....	4	8,0	..	..	13	6,5
65.....	36	36,0	..	..	..	
300.....	23	3,3	17	11,3	8	5,3
400—600....	13	4,3	..	..	3	3,0
1000—1200...	10	2,4	..	..	9	3,6
1600—2000...	1	1,0	2	2,0		

The oldest stages, over 30 mm, do not, however, seem to move up into the surface layers, but keep farther down than the intermediate stages, in which respect they closely resemble those of the foregoing species. This will be apparent from the figures given below for vertical occurrence of the stages over 30 mm.

The smallest adolescent stages below 15 mm exhibit the usual vertical distribution, *viz.* most in deeper and shallower water according to the stage of ontogenetic migration.

Length of wire in metres	No. of spec. > 30 mm	No. of hauls	Length of wire in metres	No. of spec. < 15 mm	No. of hauls
300	20	6	25	11	4
400	1	1	300	8	5
500	1	1	600	4	3
2000	1	1	1000	15	7

In this, as in most of the other *Diaphus* species, the migration is not very distinctly apparent; possibly, as mentioned, this may be connected with the fact that postlarvæ of entirely postlarval appearance may have

[1] A remarkable parallelism seems to exist between several of the Mediterranean *Scopelid*-species, both in morphological and biological respects, even down to the smallest postlarvæ. Compare for instance *Diaphus Holti* with *D. Dofleini*, and *D. Rafinesquei* with *D. Gemellarii* in respect of distribution, spawning time, size, position of photophores, pigmentation of postlarvæ etc.; and within the *Myctophum*-group, *M. punctatum* with *M. Benoiti*, and *M. Humboldti* with *M. Hygomi*.

a large part of their photophores indicated, though otherwise not exhibiting any marked signs of metamorphosis. That the metamorphosis does, however, occasion a change of locality is evident on comparison of the table above with the figures given here for vertical distribution of the largest postlarvæ (over 10 mm).

Length of wire in metres	No. of postl. > 10 mm	Percentage
25	60	75.00
65	1	1,25
300	18	22.50
1000	1	1.25

Only abt. 15 % (50 spec.) of the total number of postlarvæ were taken with 300 m. w. or over.

Eight day hauls gave 24 adult specimens; no day hauls with less than 300 m. w. gave positive result. Most of the specimens taken in day hauls are smaller stages, only one large (30 mm; taken with 400 m. w.). The rest of the material was taken in night hauls.

As regards vertical distribution of the postlarval stages, nearly all of these were taken with 25—65 m. w. as seen from the following table.

Metres of wire out	June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	23	6	376	94
65	8	5	11	44
300	5	2	37	9
> 500	3	1	5	2

Part of the material taken with great lengths of wire consists of large postlarvæ, some probably taken while hauling in.

Propagation. Postlarvæ of this species were only taken on the summer cruise, and then

Size in mm	June	July	August	Sept.
10—12	1	2	1	76
7—10	10	20	33	229
< 7	2	7	3	93
Total no. of spec. .	13	29	37	398

mostly in September, as will be seen from the table here. I should here call to mind that some postlarvæ were taken in the Ægean. *Lampanyctus maderensis* (and possibly also *Myctophum Benoiti* in the Ægean), which have, like the present species, a very restricted spawning time, — in summer — are likewise found as postlarval stages in considerable numbers in the Ægean Sea.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	March 1911	June 1910	July 1910	Aug. 1910	Sept. 1910
	..	..	..	1				
40	..	..	..	..	1			
	..	..	..	..	1	..	..	1
	..	..	..	..	1			
	..	..	1	1	4			
35	..	..	..	..	2	..	..	1
	..	..	..	..	2			
	..	..	..	..	4			
	..	..	..	..	1			
	..	..	..	..	2			
30	..	1	..	..	..	..	..	1
	..	..	..	..	..	..	..	1
	..	1						
	..	1	1	..	1			
25	1	..	2					
	..	2	1					
	..	..	4					
	..	..	7					
	1	1	5					
20	1	3	8					
	1	..	11					
	..	1	12					
	1	..	7					
	5	1	9	..	..	..	..	1
15	3	1	3	..	..	..	..	1
	7	1	..	..	..	..	..	2
	2	..	..	..	..	1	2	11
	..	..	..	..	..	..	2	6
	..	..	..	..	..	..	2	2
10								

The specimens from September were taken in the Alboran Sea. It might be imagined that some of them had been carried in by the current from the Bay of Cadiz outside, (see p. 50 and 57); the present species, however, appears to be somewhat rare in that water, and it seems most likely that they really were spawned in the Alboran Sea and hatched out there. Spawning takes place at any rate during summer, probably with a maximum in the later part of that season.

This agrees well with the occurrence of the smallest adolescent stages, as shown in the table above.

I have seen no specimens of *Diaphus Holti* larger than abt. 45 mm; but as to when maturity occurs it is impossible to say from the present material, as none of the specimens had ovaries so far developed that the eggs could be counted.

Subgenus ***Lampanyctus.***

LAMPANYCTUS MADERENSIS (Lowe).

Vert.: 35, *36*, *37*, 38; D: 13, *14*; A: 13, *14*; P: 13, *14*, 15; V: 8.

Material. The material of this species collected by the "Thor" in the Mediterranean comprises 5427 specimens, being 4330 postlarval stages and 1097 adults. This is the greatest number of individuals falling to any one species in the collections of *Scopelids*.

From the Atlantic, I have had but a single specimen indubitably belonging to this species[1]). There are some smaller ones which appear to belong to the same, but as they are not a little damaged, it is difficult to identify them properly. Moreover, in dealing with this group of *Lampanyctus* species, the Atlantic material requires particular attention, as there appears to be a species here which is closely related both to *Lampanyctus maderensis* and *Lampanyctus Warmingi*. Until the relationship between these two has been thoroughly cleared up, I have thought it best to refrain from making any comparison as to number of vertebræ etc. in *Lampanyctus maderensis* from the Mediterranean and from the Atlantic.

Literature. *Lampanyctus maderensis* was described from the Atlantic by Lowe in 1839, and it is possible that later investigations may establish the Mediterranean form as a distinct variety. The species is recorded by some of the earliest writers, and also by others more recent, from the western basin of the Mediterranean. Tate Regan (1916) had what he believed to be the postlarvæ of this species, but was here in error (see p. 94), See also Brauer (1906).

Postlarval characters. *16.5* mm (19.5 with caudal). This stage, which comes immediately before metamorphosis, may be characterised as follows. Shape slender and elongated. Pectoral large, ventral distinctly formed; anal and dorsal have, like the pectoral and ventral, the normal complement of rays distinctly formed, though not of full length; incurvation of the caudal nearly as in the older stages, but somewhat more rounded.

Occipital pigment can be present as a faint internal spot. Abdominal pigment is generally found as a couple of fainter spots. Præanal pigment present only as internal pigment on the sides of the anal papilla. Dorsal pigment: three large melanophores supracaudally, and as a rule a small one on either side of the adipose fin. Ventral pigment: four large melanophores, almost continuous, infracaudally; sometimes more. There is generally a large melanophore below the insertion of the pectoral. On the head, an antorbital pigment spot.

Photophores: indications of *Brr*, the organ at the root of the pectoral fin and that at the root of the ventral. Particularly characteristic of this species are the infracaudal and supracaudal melanophores.

11.5 mm (14) mm. Distribution of pigment at this stage same as in foregoing; unpaired fins are lower than in the foregoing; ventral short. Snout shorter than in the foregoing. Of photophores, generally the same as in older stages; the organ at the root of the pectoral fin is first formed.

7 mm (8). Distribution of pigment the same, but no indication of photophores. Large remains of the larval marginal fin-fold; anterior and basal portions of the anal indicated; of the dorsal, only a slight indication of the basal part; the ventral hardly indicated as yet. Upturned portion of the notochord distinct. Snout somewhat shorter than in the foregoing.

5 mm. Tail diphycercal, but indications of caudal fin. Larval marginal fin-fold intact. Besides the indication of the caudal, only pectoral present. The intestine makes a gentle curve. Distribution of pigment almost as in the foregoing stages, but a series of pigment spots, more or less distinct, ventrally between anus and

[1] This specimen, of 50 mm ex. C. was taken by the S/S "St. Croix" (St. 488) on 9. April 1912 with 66 m. w. (38° 34′ N, 23° 29′ W). No. of vert. 37, and distribution of luminous scales exactly as in specimens from the Mediterranean (see p. 96).

the infracaudal melanophores. Abdominal pigment often fairly prominent at this stage, as is also often the case in somewhat older stages.

The metamorphosis stage is of the usual characteristic appearance. More or less diffuse pigment over the whole of the body, strongest on the gill cover and anterior portion of the body. Of postlarval pigment, the remains of infra- and supracaudal pigment are very prominent (such remains may at times be found in specimens right up to 27 mm). Of the typical metamorphosis stages we have 5 specimens (15—22 mm) with varying number of photophores, and more or less postlarval and adult pigment. Several hundred adolescent stages also exhibit remains of the postlarval pigment. The metamorphosis stages were taken more particularly in September.

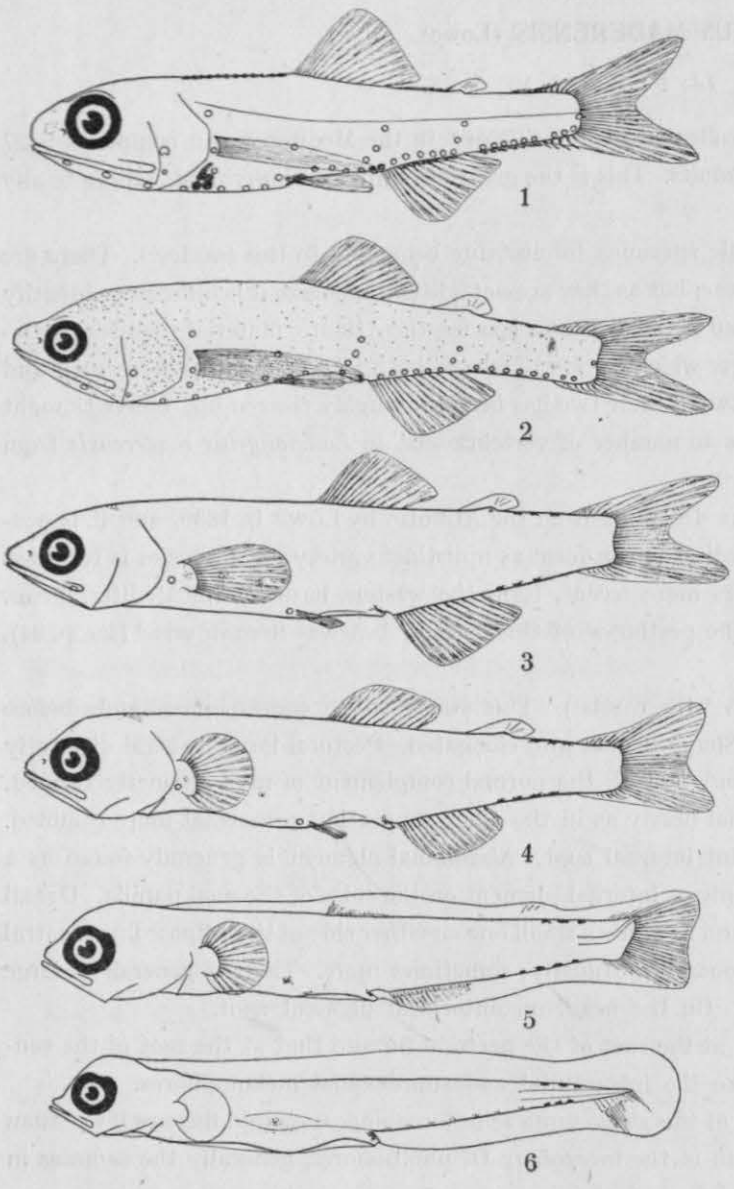

Fig. 37. *Lampanyctus maderensis*, Lowe. 1: ad.; 2: metamorphosis stage 16 mm; 3: 16.5 mm; 4: 11.5 mm; 5: 7 mm; 6: 5 mm.

Postlarval stages may be found without the slightest indication of metamorphosis character up to 19 mm (ex. C.) and the metamorphosis stages themselves vary greatly in length. It seems therefore as if the length at which metamorphosis normally takes place is rather variable; probably some decrease in length takes place when the process sets in; possibly, the length at which metamorphosis begins may be found to differ in different parts of the Mediterranean.

Fin rays and vertebræ were counted in postlarval stages, and found to be in accordance with the values noted for adults.

Regan (1916) has described and figured a postlarva (p. 140 and fig. 6, Pl. VI) of a *Scopelid* as belonging to this species. This can hardly be the case. It is stated that in a specimen of 9 mm length, the horizontal spine above the orbit was present. The earliest postlarval stage at which I have found any slight indication of this spine was 17 mm (excl. caudal) and it is often only very little formed in the smaller adolescent stages.

Adult characters.

1. No. of vertebræ. (Racial discussion).

Of this species, we have so large a material from the whole of the Mediterranean, that it was possible to make closer investigation as to number of vertebræ and number of maculæ anales in various parts of that sea. And as a result we find that *Lampanyctys maderensis* occurs in the Mediterranean in two forms, a western, belonging to the Alboran Sea and the Balearic Sea, and an eastern, having its area of occurrence in the Tyrrhenian Sea and east of the same. As to conditions in the boundary area between the two, and where such boundary exactly lies, the present material does not suffice to show.

The table for numbers of vertebræ given below is based on 7 samples from the following areas:

I. Alboran Sea (St. 99).
II. — (St. 220).
III. The Balearic Sea (St. 215).
IV. The Tyrrhenian Sea (composite sample from several stations).
V. Southern part of the Adriatic (St. 14 and 15).
VI. Bay of Corinth (St. 184).
VII. Levantine and Ægean Seas (composite sample from several stations).

It will be noticed that the western form shows an average of 36.382 and the eastern 36.800; within the different parts of each separate area the variation is but slight. Furthermore, we note that the number of vertebræ increases from west to east of the Mediteranean. A species such as *M. glaciale* shows a decrease in the number of vertebræ from the Atlantic to the Mediterranean, and thence again to the Sea of Marmora; in the present instance, however, the reverse seems to be the case, and it is therefore to be regretted that we have not suitable material of this probably southerly form from the Atlantic (see also Introduction). The number of maculæ anales also, follows, as might be expected, the number of vertebræ, the values being likewise higher in the eastern form than in the western, as will be seen from the table (6 + 6 and 6 + 5).

No. of Vert.	I	II	III	The western form	IV	V	VI	VII	The eastern form
38	..	..	..	..	..	1	1	..	2
37	8	10	9	27	17	17	13	17	64
36	16	10	14	40	5	4	7	3	19
35	.	1	..	1					
n	24	21	23	68	22	22	21	20	85
M	36.333	36.429	36.391	*36.382*	36.773	36.864	36.714	36.850	*36.800*
σ	± 0.487	± 0.609	± 0.506	± 0.522	± 0.460	± 0.504	± 0.583	± 0.415	± 0.466
Fl.	± 0.335	± 0.450	± 0.355	± 0.215	± 0.330	± 0.360	± 0.430	± 0.315	± 0.170

No. of *AO* sin.	The western form	The eastern form
13	1	4
12	33	62
11	65	34
10	1	
n	100	100
M	11.340	11.700
σ	± 0.518	± 0.546
Fl.	± 0.175	± 0.185

It may here be added that there does not appear to be any difference in the pigmentation of postlarvæ from the two areas.

2. Number of photophores etc. This species is very characteristic with regard to several characters (e. g. the spine and the luminous scales). A counting of maculæ anales in 100 specimens from each of the two different areas must suffice to give the ordinary combinations of maculæ anales anteriores and m. a. posteriores.

The table on this page shows the figures for the western form, the specimens on which it is based being all from St. 99 in the Alboran Sea; the table on the next page shows the value for the eastern form, the material here being derived from stations scattered about throughout the entire eastern area.

The western form.

Total no. of *AO*	10	11		12			13
AO ant. + *AO* post.	5 + 5	5 + 6	6 + 5	6 + 6	5 + 7	7 + 5	6 + 7
No. of spec. and percentage	1	16	49	28	3	2	1

Maculæ anales ant. or post.	5	6	7
anteriores	20	78	2
posteriores	52	44	4

It will be seen from the tables that the combinations 6 + 6 and 6 + 5 are by far the most frequent. The combination 6 + 7, which appears somewhat rare, is shown by RAFFAELE (1889—91, Pl. 7, fig. 9).

Out of the 100 specimens from the Alboran Sea, 22 (22 %) exhibited a difference between number of maculæ anales on right side and that on left. And as regards position of the organs, this was in all save three cases according to the three rules noted under *Myctophum glaciale* (p. 36). Among other abnormal cases, I

may mention the finding of one specimen which had, in addition to the normal two *Pol*, developed a third, placed in a line with and behind the uppermost, but only on the left side (both right and left sides had 5 + 6 *AO*).

3. Luminous scales etc. As regards secondary sexual characters, I have found none in this or any other *Lampanyctus*, (save for the difference in size of the eye discernible in certain species).

Brauer's description of the species as regards number and position of the luminous scales is based on insufficient material, and a further description is desirable. The position of these luminous scales, moreover, is a feature of great systematic value, and I will therefore note here the manner in which these scales are distributed in specimens over 40 mm. (The number and distribution of the luminous scales is, by the way, the same in smaller sizes).

The eastern form.

Total no. of *AO*	11		12		13	
AO ant. + *AO* post.	5+6	6+5	6+6	7+5	6+7	7+6
No. of spec. and percentage	5	29	56	6	3	1

Maculæ anales ant. or post.	5	6	7
anteriores	5	88	7
posteriores	35	62	3

Supracaudally, there are three (more rarely four) luminous scales supported by the three (rarely four) strongly curved anterior rays of the caudal fin (these hooked rays are only found in this Mediterranean form, and are most strongly developed in the grown specimens), Infracaudally, there are 7—10 (as a rule 8) luminous scales; the hindmost are also here supported by three (rarely four) highly curved rays in the front of the caudal fin (these hooked rays have likewise only been observed in this Mediterranean species, and are of nearly the same relative development in smaller and larger specimens). Between the dorsal and adipose fins there are 4—6 (generally 5) luminous scales; in front of the dorsal, 5—12 (generally 10), also serially arranged. Along the anal, there are 5—6 luminous scales; on either side of the anus, between the hindmost *VO* and the foremost *AO*, there are two. Between the ventral fins, there is in any case one large luminous scale, often with one considerably smaller on either side. Between the two foremost *PO* and lowest *PVO* we find on either side as a rule four luminous scales, the foremost of the two upper ones at times extending up in front of the lowest *PVO*. Brauer states that there are 4—6 luminous scales serially between the ventrals and the anus; this I have not found in any of my specimens from the Mediterranean[1]). The luminous scales are, as Brauer observes, white, and generally dull, not glistening. The number of luminous scales seems often though not always, to be greatest in the largest specimens.

As regards the above-mentioned hooked rays in the front of the caudal, I would here add a few remarks. The rays are bent at an angle, and much expanded at the base (this is only distinctly noticeable in preparations.) They are thus of highly characteristic appearance, and have only been observed in this Mediterranean species; they are, however, also found in the above-mentioned closely related Atlantic forms. In the two *Lampanyctus* species *L. alatus* and *L. crocodilus*, the corresponding rays in the caudal differ but little from the normal, and first commence behind the supra- and infracaudal luminous scales; the fourth of the Mediterranean *Lampanyctus* species, however, *L. elongatus*, has 7—10 pointed rays supra- and infracaudally, supporting a row of luminous scales; these rays, however, differ from the corresponding 3—4 in *L. maderensis* in having no basal expansion, nor are they nearly so strong, nor so markedly angular as those in *L. maderensis*. We have here, then, a character which may possibly be of value in classifying the *Lampanyctus* species.

I append some figures for approximate length of the caudal fin (it varies somewhat) at various lengths of the fish excl. C.:

In specimens of 20—30 mm, the caudal increases from abt. 4.5 to 7.5 mm.
— 30—40 - — — 7.5 - 9.5 -
— 40—50 - — — 9.5 - 11.5 -
— 50—60 - — — 11.5 - 14 -
— 60—70 - — — 14 - 17 -

[1] Two large specimens of this species from Madeira (Zoological Museum, Copenhagen) also lack these luminous scales (see also footnote p. 93), which are, however, to be found in other species.

Distribution. *Lampanyctus maderensis* is known from the North Atlantic up to abt. 45° N (both in the eastern and western parts); the species has also been found washed ashore on the Westmanna Islands, Iceland (20. October 1885, LÜTKEN).

In the Mediterranean, adult or postlarval specimens were taken in all places where the "Thor" fished at all, with the exception of the Marmora. The species was represented in 155 out of 208 summer hauls, and in 38 out of 117 winter hauls. This in itself suffices to show how common the species must be in the Mediterranean. As its spawning time is very restricted, we can, by noting the distribution and frequency of the postlarval stages, obtain a good idea as to the occurrence of the species in the Mediterranean. On the winter cruise, only 19 postlarval stages were taken, and I therefore confine myself here to the material from the summer hauls. Even though there may be some difference in the time at which the hauls were made in different areas, this is hardly likely to affect the results in the present connection to any extent. Postlarvæ were taken at 71 out of the 83 summer

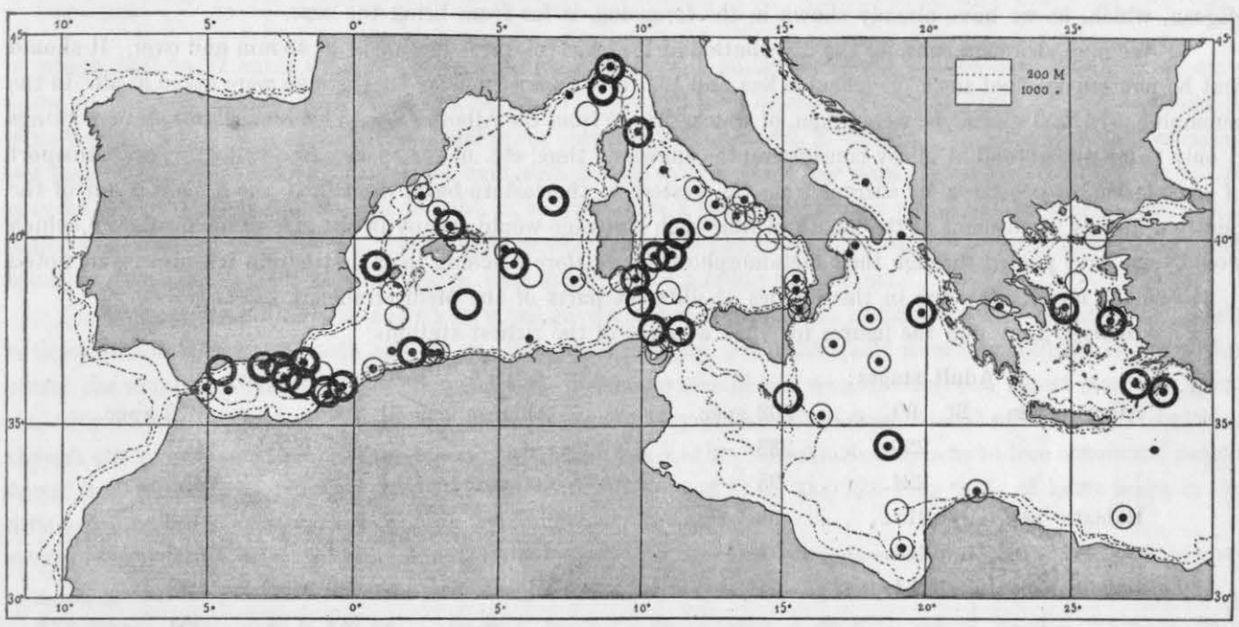

Fig. 38. Distribution of *Lampanyctus maderensis* (Lowe), according to the investigations of the "Thor"; ● adult stages, ○ < 40 postlarval specimens, ◯ > 40 postlarval specimens.

stations in the Mediterranean proper, where the young-fish trawl was used; the reason why postlarvæ are lacking at 12 stations probably lies partly in the fact that the vessel was fishing too close in to shore, partly also, to the nets having worked badly at certain stations (ten stations gave but a very poor yield, or none at all, of other *Scopelids*[1]).

In addition to the chart, the table below also gives a good idea of the conditions. The figures show the total number of postlarvæ, and number per positive hour for the summer cruise in these areas: Alboran Sea, Balearic Sea, Tyrrhenian Sea, Ionian Sea, Levantine Sea and the Ægean. Only specimens taken with 300 m. w. or less are here included (see p. 99).

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Levantine Sea	Ægean Sea
No.	1433	521	361	248	44	677
pr. hour	174	60	57	45	13	295

It will be noticed that the number of postlarvæ is high in the Alboran Sea, but decreases towards the east down to abt. $^1/_4$ of that value in the Ionian Sea, then rising again very markedly for the Ægean. Here we have 677 specimens taken in fairly equal quantities at five stations, in seven hauls, so that there must evidently have

[1] Of other organisms there are, however, from these stations at any rate some (e. g. *Chætognaths*).

been a great abundance of postlarvæ of *L. maderensis* in August. With regard to the Levantine Sea, I would add that there were but few postlarval stages taken here, save for the catch at St. 160 (41 specimens), which lies just on the boundary of the Ægean; adults also were here but poorly represented.

It should here be pointed out emphatically, that if we were to judge merely from the quantity of adult stages, we should obtain an entirely erroneous view of the frequency with which the species occurs in the different parts of the Mediterranean. The distribution of the adult stages in the areas above noted (the summer cruise) is as follows:

Area.....	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Ionian Sea	Levantine Sea	Ægean Sea
No.....	637	230	25	20	4	12
pr. hour.....	106	24	4	3	2	10

These figures alone would, as we see, give the impression that the species was of rare occurrence in the Ægean, which, as we have already shown in the foregoing, is far from being the case.

We may also here consider the distribution of the large (mature) specimens of 40 mm and over. It should first be pointed out that in the Tyrrhenian Sea and east of the same, none of these stages were taken at all. In the remaining area, 253 specimens were taken, of which 228 are from the Alboran Sea. This remarkable state of things is only to be understood at all by considering the spawning time, etc. of the species (see below). Any transport of eggs, larvæ, or postlarvæ by current from the western to the eastern basin right in to the Ægean is out of the question, if only on account of the length of time such a voyage would occupy in the case of the postlarvæ, which would then have passed through their metamorphosis long before reaching their destination (cf. also result noted p. 95—96 for no. of vertebræ in this species at different parts of the Mediterranean).

Finally, I may add the figures for yield at some of the richest stations:

Adult stages:			Postlarval stages:		
Alboran Sea	St. 99.....	202 spec.	Alboran Sea	St. 108.....	372 spec.
—	- 220.....	285 —	—	- 222.....	523 —
—	- 224.....	95 —	Balearic Sea	- 118.....	155 —
Balearic Sea	- 215.....	64 —	—	- 215.....	182 —
—	- 218.....	71 —	Ionian Sea	- 144.....	106 —
Bay of Corinth	- 184.....	41 —	Ægean Sea	- 163.....	288 —
			—	- 182.....	351 —

The species is found for the most part over great depths, especially outside the 500 metre limit, though this applies more especially to the adult stages, and to a lesser degree in the case of the denatant postlarvæ, as will be seen from the table below.

As regards vertical distribution, we find that in winter, the great bulk of the adult stages are taken with 25—65 m. w., in June with 300 m. w. and in September with 25 m. w., as the first table on the next page shows. It should be noted, however, that in June, it is almost exclusively large, mature individuals which are taken at the depth mentioned; the adolescent stages do not appear until later, at any rate in the Alboran Sea.

Soundings in metres	Total no. of stations	adults		postlarvæ	
		positive st.	No. of spec.	positive st.	No. of spec.
0—100...	18	0	0	9	290
100—500...	19	4	299[1])	9	678
500—1000..	25	12	397	18	456
1000—2000..	29	21	161	17	910
>2000..	40	22	239	27	1983

[1] Of the 299 here noted, 285 were taken at one station (St. 220 in the Alboran Sea).

It will now be interesting to note where the large specimens of 40 mm and over are found. Of these, only one specimen was taken with over 300 m. w. (day haul, 400 m. w.) all the rest were taken with 300 m. w. or less (in night hauls). This will be seen from the figures in the second table on the next page.

From this, then, we may be justified in concluding that the large, fully-grown individuals of this species

live in the upper 150 metres or so (abt. 300 metres at the outside), and do not, even during day-to-night migrations, go far beyond this depth.

With regard to vertical distribution of the postlarval stages, the following should be noted. On the winter cruise, only 19 specimens were taken, of which 12 with 25—65 m. w. On the summer cruise 4311 in all were taken,

Metres of wire out	Winter		Summer			
	Dec.—Feb.		June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	20	5	19	10	522	139
65	36	5	4	2	26	52
300	5	2	218	36	67	22
1000—2000	19	4	9	2	79	11

Metres of wire out	Winter		Summer	
	No. of spec.	No. of hauls	No. of spec.	No. of hauls
15	1	1	..	..
25	4	1	31	4
65	4	4	3	3
300	..	..	207	6
400	1	1	..	..

of which 3385 in 77 hauls with 10—65 m. w.; at stations where postlarvæ of this species were found at all, only three of the hauls made with 10—65 m. w. failed to give positive results. With 95—500 m. w. 673 individuals were taken (in 42 hauls) and with over 500 m. w. only 253 specimens (in 27 hauls). We have thus 44 specimens per haul with 10—65 m. w., abt. 18 per haul with 300 m. w. and abt. 9 per haul with more than 500 m. w. It may be added, that the hauls with over 65 m. w. yielded as a rule a far smaller number than those made in the higher levels at the same station, from which we may doubtless conclude that a certain number of the specimens taken in hauls with more than 65 m. w. were taken while hauling up the net.

As the hauls with 10, 25 and 65 m. w. all gave a rich yield, and as in summer only a few hauls were made with lengths of wire between 65 and 300 m. (five positive hauls, giving 23 spec.) it will be difficult to determine where the maximum for vertical occurrence of the postlarvæ should lie; we can, however, assert that the great majority of the postlarvæ are found in the upper water layers, abt. 30 metres, to 150 metres at the outside; though the postlarvæ taken in June (from the Alboran Sea and the Balearic Sea) appear to live somewhat deeper down than those from the following months. This will be seen from the following table of hauls made in the different months at the various depths.

Metres of wire out	June			July			August			September		
	No. of spec.	No. of pos. hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour
25	90	4	90	834	20	88	742	20	102	919	10	245
65	317	8	91	10	1	20	343	7	172	"	0	"
300	309	7	88	107	14	14	84	10	25	119	6	48
1000—2000	61	4	15	93	12	9	98	10	17	2	1	4

As the smallest adolescent stages do not appear in any quantity until August and September in our material, and as hardly any deep hauls (1000—2000 m. w.) were made in September, the investigation of the vertical distribution of the smallest adolescent stages must be restricted to the month of August (comprising material from St. 160—215, i. e. the area from the Ægean to the Balearic Sea, but not the Alboran Sea). I have here selected the stages under 20 mm, which come immediately after the metamorphosis stage.

Metres of wire out	Total no. of ad. spec. < 20 mm	Percentage
10—25	68	48.6
65	10	7.1
300	3	2.1
600	4	2.9
1000—2000	55	39.3

It will be noted that there are large numbers at the greater depths and in the upper water layers, suggesting a comparatively rapid ascent of the metamorphosed individuals to the higher levels, which constitute the true habitat of the species at this season. It is to be regretted that there were not more deep hauls made at the stations in the Alboran Sea; we have from here 432 specimens of less than 20 mm in September, and we might

thus expect that deeper hauls here at the proper places would have given a very rich yield of recently metamorphosed stages.

In this connection, it will be natural to investigate whether the different stages of postlarvæ live at different depths. For the purpose of this investigation, I must take the material from the month of June, St.104—118, as this will give a sufficient number of hauls with 25, 65 and 300 m. w. and we may reckon that in that month a number of postlarvæ really were to be found at the depth fished by 300 m. w. (see p. 99); furthermore, we shall then be dealing with a restricted area. With over 300 m. w., only 61 specimens were taken in the same area (four hauls). The figure noted above in parenthesis must be disregarded, as being probably too high in proportion to the rest. It would then seem, that the postlarvæ up to a length of 15 mm are found in the upper layers, not divided at different depths according to size.

Size in mm	25 m. w.			65 m. w.			300 m. w.		
	No. of spec.	No. of pos. hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour
10—14	65	1	(260)	37	4	19	58	7	17
7—10	82	5	66	55	7	18	144	6	48
<7	83	5	66	223	7	74	107	5	43

With the postlarvæ of 15 mm and over, on the other hand, i. e. those nearing metamorphosis, we find a very different state of things. I have here taken all the available postlarvæ of 15 mm and over, comprising 54 specimens in all.

Metres of wire out	No. of postl. > 15 mm	Percentage
25	5	9
65	8	15
300	22	41
> 300	19	35

We find then, in these large postlarvæ, a distinct tendency to (active or passive) downward movement. It may be added that out of the total number of postlarvæ (5 mm and over) only abt. 6 % were taken with over 300 m. w.

With regard to day-to-night migration of adult specimens, we find the following:

of 1009 specimens taken in 80 night hauls, 63 were taken with over 500 m. w. (21 hauls).
of 66 specimens taken in 9 day hauls, 61 were taken with over 500 m. w. (in 7 hauls).

I have here, as before, only included hauls made at stations where the specimens was positively represented.

With less than 500 m. w. 14 day hauls were made in winter, of which 2 with positive result (4 spec.), 7 day hauls in summer, 1 with positive result (1 spec.). The sizes of these specimens from the day hauls were: one of 45 mm, four of 20—22 mm and they were taken with 300—400 m. w. Of the 124 specimens mentioned above as taken with over 500 m. w. in day hauls, (abt. 12 % of 1075 specimens) 114 were under 25 mm (62 under 20 mm) and most of them would thus in all probability naturally belong to the depths at which they were taken, so that they need not be supposed to have moved down in the course of any day-to-night migration. Some were possibly taken while hauling in. And I would here call to mind that practically none of the grown specimens were taken with lengths of wire beyond 300 m.

Spec. taken with over 500 m w.	Day hauls				Night hauls			
	Total no. of hauls	No. of pos. hauls	Total no. of spec.	No. pr. hour	Total no. of hauls	No. of pos. hauls	Total no. of spec.	No. pr. hour
Winter	10	3	17	5	9	4	5	1
Summer ...	7	4	44	11	26	17	58	5

We may say, then, that the vertical day-to-night migration of *Lampanyctus maderensis* — if any takes place — will be restricted to the upper 150 m or so, (the range fished with 300 m. w. or less).

As regards possible day-to-night migration of the postlarvæ, the following may be noted. All day hauls with 65 m. w. or less gave positive result, albeit not so rich a yield as the night hauls, (those with 25 m. w., however,

close on 100 spec.). And this can only be interpreted as meaning that the postlarvæ do not make vertical migrations of any great extent during the 24 hours. If any such movement takes place, it must doubtless be restricted to quite short distances, not appreciable in working with the lengths of wire used by the "Thor" in the Mediterranean.

Propagation. We have only 19 postlarvæ of this species from the winter cruise, but 4311 from the summer, whence it seems obvious that the spawning time must be far more restricted than is that case with most other *Scopelids*.

A glance at the accompanying graph, showing the sizes of *Lampanyctus maderensis* represented in the material from the "Thor" will at once make it apparent that in summer, the species occurs in very sharply defined year-groups, while the winter material, which is surprisingly small in comparison to the summer material, to some extent gives the transition forms between the two size groups. The graph for the summer material includes one specimen of 70 mm as an entirely isolated case. And as we find in the literature records of specimens from 75—95 mm (with caudal) which appear to collect in a large year-group, it follows that there must be one or more groups of large individuals beyond that for sizes about 45 mm. That the "Thor" found but few of these largest sizes — as also in the case of the remaining *Scopelid* species which can attain such length — is perhaps chiefly due to the hauls not having been made with implements properly adapted to the capture of such; possibly also there are but few of these largest specimens to be caught at all.

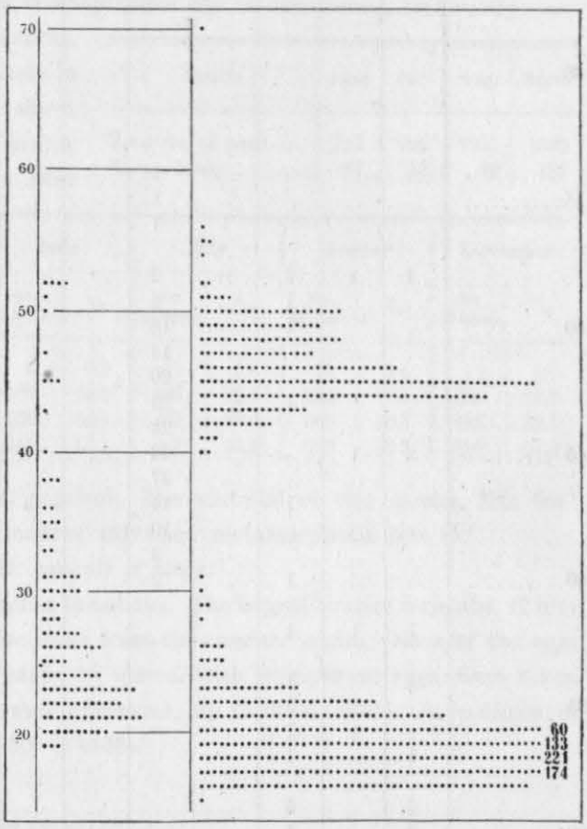

Fig. 39. *Lampanyctus maderensis*. Length in mm of specimens from the winter cruise (first column) and the summer cruise (second column).

Lampanyctus maderensis is thus represented in the summer material by three year-groups (Group 0, Group I and Group II (?)) and can, as we see, attain an age of several years, though it is not yet certain whether this is generally the case.

We will now pass on to consider the occurrence of the various sizes during the different months, and in different parts of the Mediterranean.

The winter material of adult stages shows that the bulk of the yield for December consists, on an average, of smaller fish than that for January, the sizes in this latter month again being inferior to those of February. In December, the vessel was working in the Adriatic and Ionian Seas; in January, in the Tyrrhenian, and in February, in the Balearic and Alboran Seas, and we might imagine than the gradual increase in size from month to month could perhaps be due to a difference in the time at wich spawning takes places in the areas concerned. As we shall see, there seems also to be some such difference, the eastern Mediterranean form having apparently its spawning time earlier than the western Mediterranean form. We have also, however, to consider the natural possibility that the difference merely expresses directly the manner in which the species has grown from month to month.

As already mentioned, it was only during the first part of the winter cruise that some few postlarvæ were taken (19 spec. from 7 to 18 mm) most of them in the Tyrrhenian Sea, and none in the Balearic Sea or the Alboran Sea. How far these postlarvæ from the winter cruise should be regarded as stragglers from the previous year's spawning, or as heralding the commencement of the new season, is doubtful; possibly some few spawning individuals may be met with all the year round.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	March 1911	June 1910	July 1910	Aug. 1910	Sept. 1910
70	..	..	..	..	..	1		
65								
60								
	..	..	..	..	1			
55	..	..	..	..	1	..	..	1
	..	..	..	1	1			
	1	1	2	..	2			
	..	..	1	..	4	..	..	1
50	..	..	1	..	18	..	..	3
	..	..	..	..	14	..	..	4
	..	..	..	..	20	..	..	1
	..	..	1	..	13	..	..	4
	..	..	..	..	24	..	..	6
45	2	1	..	..	43	..	..	6
	..	..	..	..	37	..	..	4
	..	..	1	..	14	..	1	
	..	..	..	..	10	..	..	2
	..	..	..	..	3			
40	..	..	1	..	2			
	1	1	1					
	1	..	1					
35	..	..	3					
	..	1	1					
	1	..	1					
	1	..	5	..	..	..	..	1
30	2	..	4	..	..	1		
	..	1	2	..	..	..	1	1
	..	2	1	..	..	..	..	1
	2	3	1					
	3	4	2	..	..	..	..	4
25	3	1	..	..	..	1	1	2
	7	1	1	..	..	..	1	3
	12	2	..	..	..	8	5	2
	9	3	..	..	..	11	13	2
	9	5	1	..	..	13	21	3
20	10	..	..	..	..	7	32	20
	3	..	..	..	2	1	47	83
	..	..	..	..	1	..	60	160
	..	..	..	..	1	..	20	153
	..	..	..	..	..	..	13	35
15	..	..	..	..	..	..	..	1

From the Strait of Messina we have only a single individual of this species of 54 mm from March 1911; i. e. from the same time at which it is said by MAZZARELLI (1910) to be taken there.

In June, we find a great number of large specimens, and a very slight occurrence of the smallest adolescent stages; these last increase considerably in numbers during the following months, culminating in September. A conspicuous feature to be seen in the table on this page is the fact that the large individuals (Group I) are entirely lacking during the time that the "Thor" on the summer cruise was fishing in the eastern part of the Mediterranean (July—Aug.), but reappear, albeit less numerously represented, when the vessel returns in September to the western waters (the two specimens over 40 mm from July and August were both taken in the western Basin). Transport of eggs, or of larvæ and postlarvæ from the western basin to the eastern, right in to the Ægean, is entirely out of the question, not only on account of the time which such drifting with the current would involve, but also because quite small postlarvæ (5—7 mm) were taken in quantities in the Ægean, and finally, because investigation of the number of vertebræ in specimens from different parts of the Mediterranean has shown that there are stationary forms in the western and eastern parts. There remain then, only two possible explanations of the absolute lack of large specimens in the eastern part during the summer cruise; *viz.* either that their not having been taken here by the "Thor" is purely accidental, or that spawning in the eastern part was over — possibly owing to the higher temperature — before the "Thor" reached these waters, and that the majority of large individuals had then, after spawning, disappeared. The latter alternative must probably be accepted as correct, and the former discarded, since the species in the Ægean for instance, must be said to be extremely common, and as the "Thor" was able to find large specimens of other species, and did on the winter cruise find such in the eastern basin. It is nevertheless highly desirable to have the question further investigated.

From the Alboran and Balearic Seas, on the other hand (i. e. from the area of the western form) we have ample material for a clear exposition of the conditions here with regard to spawning etc. As already mentioned,

there were in June only few adolescent stages, but many both of spawning adults and of the smallest postlarval stages. In September, when the "Thor" was fishing in the same waters, there were quantities of the adolescent and postlarval stages, but only few adults over 40 mm. By way of illustration, I will quote the catches made at two stations in the Alboran Sea, one in June and the other in September. In June, St. 99 gave 202 specimens, all of 40 mm or over; in September, St. 220 gave 285 specimens, of which 276 were between 15 and 25 mm, and only 4 over 40 mm. The two tables on this page also show clearly that *Lampanyctus maderensis* in the western Mediterranean spawns especially about midsummer.

The first table shows the number of postlarvæ taken with 10—300 m. w. during the four months from June—September, with the numbers per positive hour. June and September can, as mentioned, be directly compared, as the vessel was fishing the same area in these two months, and we see also how greatly the number of postlarvæ increases in the course of the two months between. The second table shows the total number of postlarval stages from the summer cruise, divided into four size-groups. Here also we compare the June material with that from September, and find a decrease in the smallest sizes together with a distinct increase in the numbers of the larger. We can therefore assert, that the spawning season is at its height some time before September, and probably after June. Not until July were the first metamorphosis stages taken, and in September, we find numbers of adolescent stages with remains of the postlarval pigment. The material of this species, like that of other *Scopelids*, suggests that the postlarvæ are abt. 2 months old when metamorphosis sets in.

Month	June	July	Aug.	Sept.
Total no. of postl....	717	995	1305	1038
No. pr. hour	87	52	89	166

Size of postlarvæ in mm.	June		July		August		September	
	No. of spec.	%	No. of spec.	%	No. of spec.	%	No. of spec.	%
15—19.....	6	0.8	18	1.6	19	1.4	11	1.1
10—15.....	109	14.0	247	22.7	264	18.8	226	21.7
7—10.....	250	32.1	421	38.6	568	40.5	413	39.7
< 7.....	413	53.1	404	37.1	552	39.3	390	37.5

Maturity is attained at a length of abt. 40 mm (excl. caudal) or more.

Investigation of the ovaries serves on the whole to confirm the above. The largest ovaries were abt. 12 mm long and 3.25 mm greatest breadth; these were found in specimens from the summer cruise. None of the eggs measured reached 0.5 mm in diameter. No specimens fully ready to spawn, with transparent eggs, were taken at all, (the eggs were as a rule 0.35 mm or less). The eggs were numerous; up to nearly 2600. A specimen of 46 mm with eggs abt. 0.32 in diameter contained 2387 (1219 + 1168).

LAMPANYCTUS ELONGATUS (Costa).

Vert.: 38, *39*, 40; D: 22, 23, *24*, 25; A: 18, *19*, 20; P: *13*, 14; V: 8.

Material. Of this species, we have 651 specimens from the Mediterranean, comprising 620 postlarval stages, and only 31 adults. The greater part of the material is from the "Thor"; but Capt. G. Hansen collected 84 postlarvæ of the species at Messina in March 1911. I had also a quantity of material from the Atlantic.

Literature. This species was described by Costa in 1844 from the Mediterranean; it has frequently been recorded from here, and from the Atlantic. See also Brauer (1906).

Postlarval characters. *12 mm* (14.5 with caudal). This stage, which comes somewhat before metamorphosis, can be characterised as follows. Powerfully and compactly built. Pectoral large, and has, like the remaining fins, all rays distinctly formed, but the fins have not yet attained their subsequent shape. No remains of the larval marginal fin-fold, which in *Lampanyctus* species disappears at a very early stage. Eye circular.

Occipital pigment occurs, generally paired melanophores, which may, however, partially fuse. Abdominal pigment may be present in the form of small, often internal melanophores. Præanal pigment as a few scattered melanophores. Dorsal pigment as a long row of large melanophores, running from the head on either

side of the dorsal fin nearly to the caudal. Mediolateral pigment as a distinct stripe in the caudal region. From this proceed fainter pigment stripes, following the myotomes. Ventral pigment as a row of large melanophores along the anal fin and somewhat behind the same. On the head, there are melanophores at the point of the snout, and at the point of the lower jaw, and elsewhere. There are often small melanophores scattered about especially in the forepart of the body and on the ventral fin. Photophores: a *Brr* (No. 2), and the hindmost *PO* at root of ventral

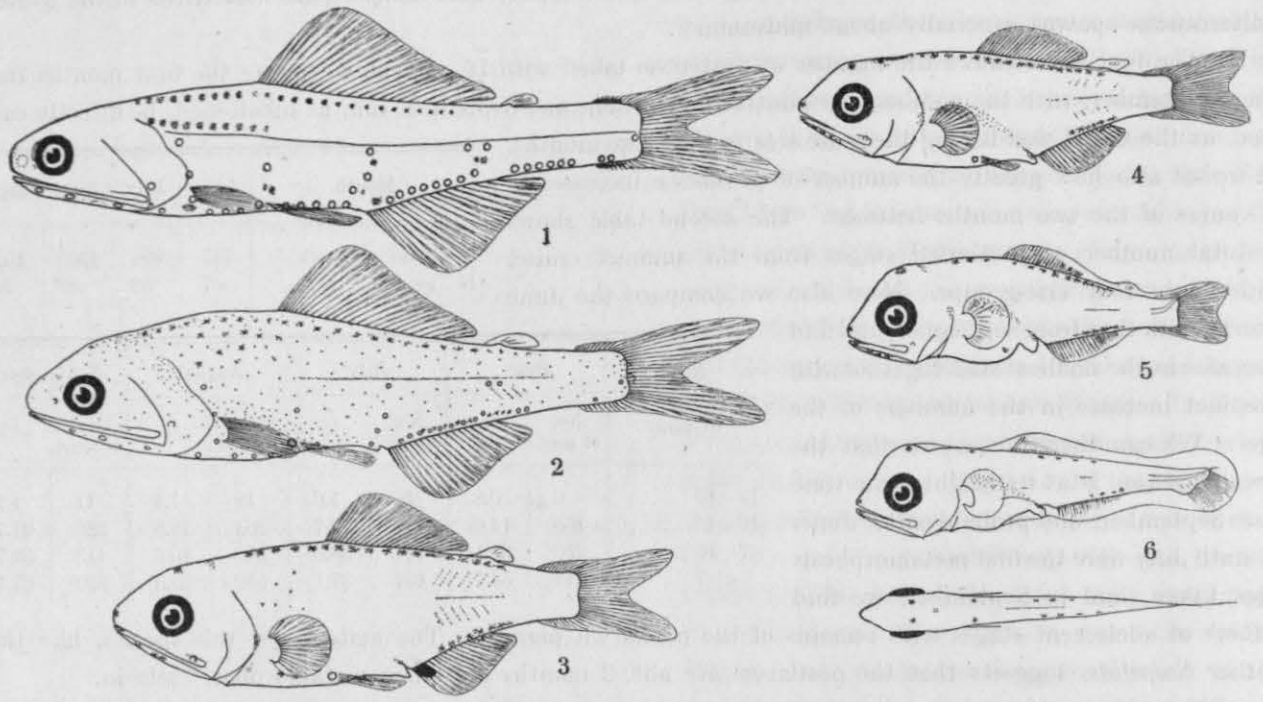

Fig. 40. *Lampanyctus elongatus* (Costa). 1: ad. ♀ (62 mm); 2: metamorphosis stage 21.5 mm; 3: 12 mm; 4: 8.5 mm; 5: 6.5 mm; 6: 6 mm (lateral and dorsal view).

fin. This organ is particularly large and prominent, also in the following postlarval stages and in the adolescent stages also. Particularly characteristic for this species are the dorso-, ventro- and mediolateral pigment stripes.

8.5 mm (10.5). This stage does not differ essentially from the foregoing, but is of somewhat more larval appearance.

6.5 mm (7.5). Distribution of pigment is in the main the same as in the foregoing stage. More larval appearance, seen, *inter alia*, in slight remains of the larval marginal fin-fold, incomplete formation of rays in posterior parts of dorsal and anal fins, development of the ventral fin, which is only slightly indicated, prominent curve of the intestine etc. Of photophores, traces of *Brr*.

6 mm. Posteriorly the notochord is slightly bent; distinct indication of the caudal fin. Larval marginal fin-fold intact; dorsal, anal and pectoral rays not formed, or only slightly so. Pigmentation mainly as in older stages, but far less prominent, at times even partially obliterated; there are, however, nearly always a couple of the dorsal or occipital paired melanophores.

The metamorphosis stage is of the usual characteristic appearance. Postlarval pigment: remains of the characteristic dorso-, medio- and ventrolateral stripes especially prominent. Of the typical metamorphosis stages we have 2 (19.5—21.5 mm) with more or fewer of the photophores characteristic of the species. The metamorphosis stages were taken in March and June, at Messina and at a great depth. Some of the smallest adolescent stages exhibit very distinct remains of the postlarval pigment.

Fin rays and vertebræ were counted in postlarval stages and found in agreement with the values noted for older stages.

The postlarva is figured by FAGE (1910) in fig. 13 p. 15; none of the characteristic pigment is shown in the figure, but there is no doubt that FAGE was right in referring the specimen in question to the present species, as the number of fin rays in the dorsal precludes the possibility of its being any other.

BRAUER (1906) had small stages of this species (15—22 mm long; p. 234) from the Atlantic (Gulf of Guinea and west of Cape Colony).

Adult characters. 1. No. of Vertebræ. Vertebræ were counted in 20 specimens from various stations in the western basin of the Mediterranean. Seven had 38 vertebræ, 12 had 39, and one had 40. As regards the Atlantic, 10 specimens were examined, from various stations on the cruise of the "Margrethe"; all had 39 vertebræ[1]).

2. No. of photophores etc. Only 28 specimens of this species were examined for number of photophores; the combinations of *AO* ant. and *AO* post. there found will be seen from the following table.

In this respect, the present species appears to vary far more than the others here dealt with, variation being observable not only in the *AO*, but also in *PO*, *VO*, *Prc* and *Pol*. *PO* I have found to number 5 or 6, for *VO* there are records in the literature of 5 or 6, *Prc.* may be 3 or 4, generally 3, and of *Pol* I have found 2 or 3, none of the specimens seemed otherwise to differ in any respect from the normal. The size of the photophores themselves appears also to be subject to some variation. *PO* at the root of the ventral is, as mentioned, considerably larger than the remaining photophores, the difference being most distinct in the smaller individuals.

Total no. of *AO*	13	14		15		16
AO ant. + *AO* post.	7 + 6	7 + 7	8 + 6	8 + 7	9 + 6	9 + 7
No. of specimens	1	2	11	4	3	7
Percentage	3.6	7.1	39.3	14.3	10.7	25.0

Maculæ anales ant. or post.	6	7	8	9
anteriores	..	3	15	10
posteriores	15	13	..	..

The species *Lampanyctus castaneus*, established in 1895 by GOODE and BEAN, with 3 *Pol*, D: 20, 21; A: 16 and *AO* 9 + 4, differs thus in respect of the last three characters from the present species, and not very markedly so in any case. Altogether, the various species which have been grouped about this present form need to be thoroughly revised. I have found in the material 3 specimens with 3 *Pol*, (two of these fish were from the Bay of Cadiz, only one from the Mediterranean)[2]). Of these, two had 3 *Pol* on the left side, and the normal number (2) on the right; the third had 3 *Pol* both right and left. The 3 organs lie serially; otherwise, no essential difference between these individuals and normal ones in the remaining characters.

3. Luminous scales. LÜTKEN, GOODE & BEAN, and BRAUER all mentioned the luminous scales. I have in the largest specimens observed the following distribution of the many luminous scales. Supra- and infracaudally 6—7, supported by the short, stiff rays in the front of the caudal fin; below the lowest *PVO* one scale, between the ventral and *VLO* 1—2; in front of foremost *AO* ant. 1; dorsally, two long rows of luminous scales (one row on either side of D) consisting of abt. 25 scales; laterally above the forepart of the lateral line, there are abt. 10 luminous scales; under *Pol* a couple, and at *SAO* likewise two. (See GOODE and BEAN 1895, fig. 94, pl. XXV).

The length of the caudal fin appears to be as follows:

In specimens abt. 20 mm C. is abt. 5 mm long.
— — 30 - — 7 -
— — 40 - — 10 -
— — 50 - — 12 -
— — 60 - — 13 -

[1] With regard to the urostyle in the smallest stages of this species, the same applies as noted in the foregoing for *Myctophum Rissoi* p. 29.

[2] The specimen shown by COSTA (1844, Pl. XXXV) has 3 *Pol*.

Distribution. This species is recorded from a wide range of the Atlantic (from Greenland to the Cape of Good Hope). In the Mediterranean, it is found only in the western basin; its precise distribution here will be seen from the chart and the table below.

Area	Alboran Sea	Balearic Sea	Ligurian Sea	Tyrrhenian Sea	Str. of Messina
Adults	17	10	4	0	0
Postlarvæ ..	299	132	47	58	84

The greatest number of adults taken at any single stations is 7 (from St. 59 and St. 220 in the Alboran

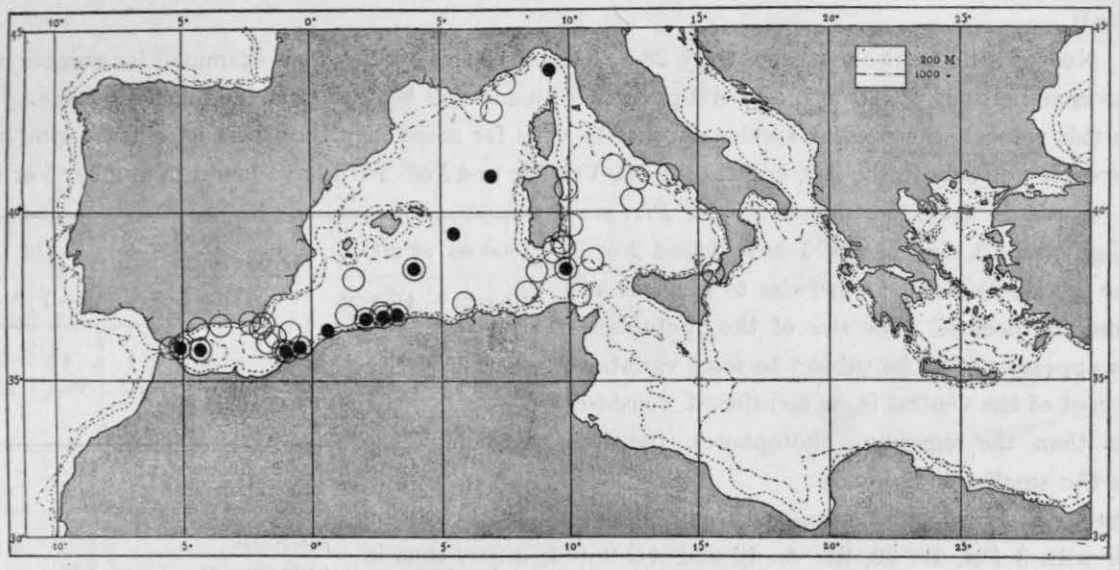

Fig. 41. Distribution of *Lampanyctus elongatus* (Costa), according to the investigtions of the "Thor"; ● adult stages, ○ postlarval stages.

Sea). The postlarval stages, on the other hand, were taken in considerably greater quantities. By way of example the following may be noted:

St.	35 (Ligurian Sea)	41 spec.
-	38 (Tyrrhenian Sea)	32 —
-	47 (Balearic Sea)	43 —
-	57 (Alboran Sea)	90 —
-	108 —	55 —

The species is found, like the remaining *Scopelids*, chiefly over the greatest depths in the Mediterranean. In winter, however, we find in the Alboran Sea a quantity of postlarvæ in the shallower water to the north (St. 55, 57 and 58; cf. *Myctophum glaciale* p. 40); in winter, we have 171 specimens (out of 337) from inside the 700 m limit, in summer only 18 (out of 199).

Metres of wire out	No. of adult spec.	No. of hauls
25	13	4
65	3	2
300	7	7
600	1	1
1200	2	1

Vertical distribution of the adult stages will be seen from the accompanying figures.

Both the largest and the smallest stages appear to be fairly evenly distributed throughout the different catches made with 25, 65 m. w. etc. The species was only taken in night hauls, and seems to keep, at any rate during this part of the 24 hours, to the upper 150 metres or so.

Distribution of the postlarval stages will be seen from the table below, where we find, by the way, the usual state of things with regard to vertical occurrence at the different seasons. It should be noted that nearly

all the summer material was taken in June, only abt. 35 from the other summer months (in nearly all cases with 300 m. w.).

Metres of wire out	Winter		Summer	
	No. of postl.	pr. hour	No. of postl.	pr. hour
25	88	12	1	2
65	100	13	39	26
300	73	10	143	20
> 300	6	2	16	4

None of the postlarval stages over 15 mm (22 spec.) were taken with 25—65 m. w.; these stages have already commenced their ontogenetic migration.

No day-to-night migration can be discerned among the postlarvæ, which are to be found in the upper water layers both day and night.

Propagation. *Lampanyctus elongatus* is one of the largest *Scopelid* species, specimens of 145—150 mm being known (COLLET, 1885 and 1903; CARUS, 1889—93). It is doubtless also to be reckoned as one of the swiftest-moving forms, which will account for the paucity of adult stages in our material of the species, which to judge from the material of postlarval stages must be quite common in the western Mediterranean.

The "Thor" worked over nearly the same parts of the area of distribution in February, June and September, and an investigation of the quantities and sizes of postlarval stages taken during these three seasons will therefore be interesting as regards the question of spawning time. In February, 247 postlarvæ were taken, in June 164, and in September only 30; these figures in themselves seem to show that spawning must take place from winter to summer. The following table gives a clearer view.

Size in mm	Feb.		June		Sept.	
	No. of sp.	%	No. of sp.	%	No. of sp.	%
> 15	4	1.7	15	9.2	4	13.4
10—15	31	12.5	54	32.9	10	33.3
7—10	107	43.3	62	37.8	15	50.0
< 7	105	42.5	33	20.1	1	3.3

I may further add, that in January, 90 specimens were taken, of which only 5 were over 10 mm and none over 15 mm; in March, again, a considerable number of large specimens were taken near Messina.

Size in mm	Feb. 1909	June 1910	July 1910	Sept. 1910
60	1			
	..	..	1	
55				
	..	..	..	1
50				
	..	1	..	1
45				
	..	..	1	
40	..	..	1	
	..	..	1	
	..	..	1	
35				
	..	1	..	1
30	..	1		
	..	..	..	1
	1			
25	..	..	..	1
	..	..	..	1
	..	1	..	1
	5	1	..	4
20				
	1			
	2			
15				

Maturity seems to be first reached at a considerable length, which is what we might expect in the case of so large a species; in any case, the only female in our material with ovaries far enough developed for the eggs to be counted, measured 62 mm (taken in February). The ovaries were abt. 14 mm long, and abt. 3.5 mm broad; the largest eggs, of which there were abt. 3600, measured abt. 0.26 mm in diameter. The species thus appears to be one of the most fertile among those I have investigated; it is likely, however, that *L. crocodilus* will surpass it in this respect.

LAMPANYCTUS ALATUS, Goode and Bean.

Vert.: 32, *33*, 34; D: 11, *12*, 13; A: *14*, *15*; P: 13, *14*, 15; V: 8.

Material. Of this species, we have from the Mediterranean 515 specimens, of which 202 are postlarval stages, and 313 adults. The entire material was taken by the "Thor". From the Atlantic, I had a considerable quantity of material of this species.

Literature. The species was described by GOODE and BEAN in 1895 from the Atlantic. From the Mediterranean, it is first mentioned by ZUGMAYER (1911). That it should have been left unrecorded so long in these waters is probably due to its having formerly been confused with *L. crocodilus;* I have been able to convince myself as to this by going through the material of *Scopelids* at the Zoological Museum of Copenhagen. The species is here found together with *L. crocodilus*, sent in from the Strait of Messina, and labelled with the name of the latter species. This is further confirmed by statements in the literature. GÜTNHER (1864) mentions on p. 414 a species *Scopelus bonapartii*, having *inter alia* the following characters: D: 13, A: 15, L. lat.: 32; length of a specimen from the Mediterranean abt. 44 mm. Possibly it is GÜNTHER's statement which we find repeated in other works. CANESTRINI (1871—72) gives the number of fin rays in *Scopelus Bonapartii* as D: 13 and A: 15, and adds: "Sinonimia: *Scopelus crocodilus* Riss.?" CARUS' figures for number of fin rays in *Lampanyctus crocodilus* likewise differ from the values I have found. I consider it highly probable that GÜNTHER's *Scopelus bonapartii* is in reality identical with this species, and the name "*bonapartii*", which has been handed about between one or two other *Lampanyctus* species, would here be properly applied, and it would therefore be interesting to have GÜNTHER's material subjected to renewed investigation. I have never, in specimens from the Mediterranean, found the values 16, 17 and 18 for number of rays in the anal. See BRAUER (1906)[1]).

Postlarval characters: *10 mm* (12 mm with caudal). This stage which comes shortly before the metamorphosis, may be characterised as follows. Shape short and plump, (note the low number of vertebræ in this species). The pectoral has lost something of its larval appearance, and has, like the other fins, all rays distinctly formed; the fins have not yet attained their subsequent shape. No remains of the larval marginal fin-fold. Eye circular. In this stage, we find small melanophores spread over the whole of the body, especially the anterior portion; there is, however, a long row of large dorsal melanophores distinctly visible (the dorso-lateral line); generally a large melanophore between the dorsal and adipose fins; an accumulation of pigment along the lateral line, so as to form a mediolateral stripe; also a row of large præanal melanophores. Of photophores, only *Brr.*

8.5 mm (10). Still shorter and more rounded in form than the foregoing. There are now fewer of the small scattered melanophores on the body generally, so that the more prominent melanophores above mentioned show up even more distinctly. The pigment on the snout also, and on the point of the lower jaw, posterior margin of the gill cover, and point of the clavicles, is more prominent than in the foregoing stage. Occipitally, there is generally one melanophore in a line with a couple out towards the snout. Of photophores only *Brr.*

6.5 mm (7.5). Small scattered melanophores still present; the distribution of the pigment exhibits a faint indication of the arrangement seen in the above. Shape still shorter than the foregoing. Of the larval marginal fin-fold very little, if anything at all, remaining. Ventral fin indicated.

[1] In the specimens from the Mediterranean and the Atlantic, I have never seen *VLO* in any other position than that given by the following sketch; this position is also shown by GOODE and BEAN (1895) in fig. 92; in BRAUER's fig. 161 (1906), however, the position of *VLO* is quite different. The reason why the present figure (fig. 42, 1) and BRAUER's figure (1906, fig. 161, text p. 244—246) do not agree, has proved to be that there exists an Atlantic species, which is very close to *L. alatus*. I propose the name *Lampanyctus pseudoalatus* for this species. It is easily distinguished from *L. alatus* (GOODE and BEAN (1895), fig. 92, text p. 79) through the following features (from 4 Atlantic specimens 21—35 mm without caudal: S/S "Texas" St. 752, $^{20}/_{10}$ 1913, 20°00′ N, 21°55′ W; M/S "Margrethe" St. 1030, $^{1}/_{10}$ 1913, 35°31′ N, 55°58′ W): *VLO* close to lateral line; *AO*: 6 + 8 — 9; *A*: 17—18 rays; vertebræ: 35 (from one spec.); a luminous scale anteriorly in the adipose fin.

BRAUER's figure 161 is *L. pseudoalatus*; his material has possibly included both species. *L. pseudoalatus* does not occur in the present material from the Mediterranean.

5 mm. Tail almost diphycercal. Only slight indications of the fins D, A and C. Larval marginal finfold intact. Pigment: a little, partly internal, abdominal, some on the gill cover and snout, also on the point of the lower jaw.

A feature but indistinctly discernible in the figures is the single occipital melanophore found in most stages; it can at times be secondarily dissolved into two; also out on the snout, in front, there are as a rule two melanophores in a line.

The metamorphosis stage of this species is represented by only a single specimen (12 mm excl. caudal, 14.5 with same) not very well preserved. Only a few of the photophores are indicated, and these but faintly. We find, however, the pigment characteristic of the foregoing stage; the supra- and infracaudal luminous scales are likewise formed. In smaller adolescent stages of 13 mm length (ex. C.) the lateral line often appears as a darker

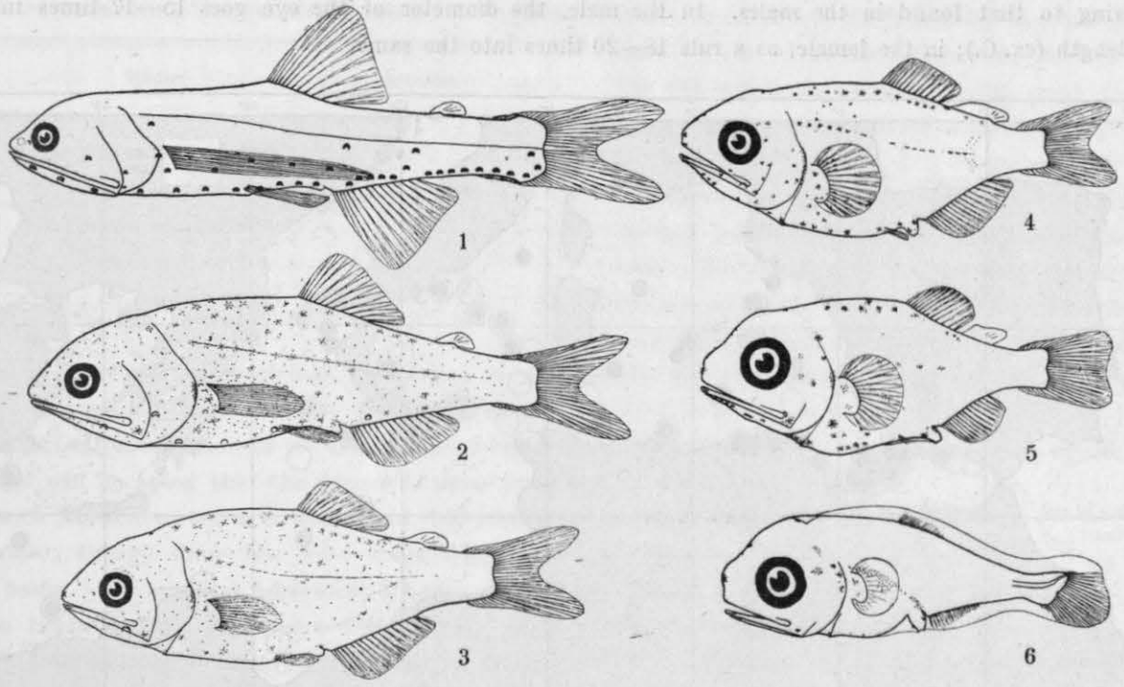

Fig. 42. *Lampanyctus alatus*, Goode and Bean. 1: ad. ♀; 2: metamorphosis stage 12 mm; 3: 10 mm; 4: 8.5 mm; 5: 6.5 mm; 6: 5 mm.

stripe, which seems to suggest preservation of some postlarval pigment. The above stage was taken together with the figured stage of 10 mm, with 2000 m. w. in June.

It should be noted that in this species, the eye is relatively reduced in size on metamorphosis.

In all the mentioned stages where rays were formed, the numbers were seen to be entirely in agreement with the values found for adults. As far as I am aware, this postlarva has not previously been described or figured by any writer.

Adult characters.

1. No of vertebræ. The vertebræ were counted in 25 specimens from the western basin of the Mediterranean (St. 108 in the Alboran Sea St. 115 and 116 in the Balearic). Of these, 6 had 32 vertebræ, 18 had 33 and 1 had 34. From the Atlantic 24 specimens were examined for this character, and like values were here found (see also Introduction p. 23).

2. No. of photophores etc. The maculæ anales were counted in only 100 specimens of this species; the various combinations of *AO* ant. and *AO* post. will be seen from the following table. It should be added, that

Total No. of *AO*	11	12		13		
AO ant. + *AO* post.	4+7	4+8	5+7	5+8	6+7	4+9
No. of spec. and percentage	8	36	36	18	1	1

Maculæ anales ant. or post.	4	5	6	7	8	9
anteriores	45	54	1			
posteriores	..	..	..	45	54	1

I have in this species, as in the following, reckoned with 2 *Prc* and 2 *Pol.* The photophores are kidney-shaped, both in this and the following species, in contrast to the conditions in the two preceding species of this group.

3. Secondary sexual differences etc. BRAUER points out that the eye in the male is larger than in the female; this I am able to confirm, but must add that I have met with a single female specimen having the eye of a diameter answering to that found in the males. In the male, the diameter of the eye goes 15—17 times into the total length (ex. C.); in the female, as a rule 18—20 times into the same.

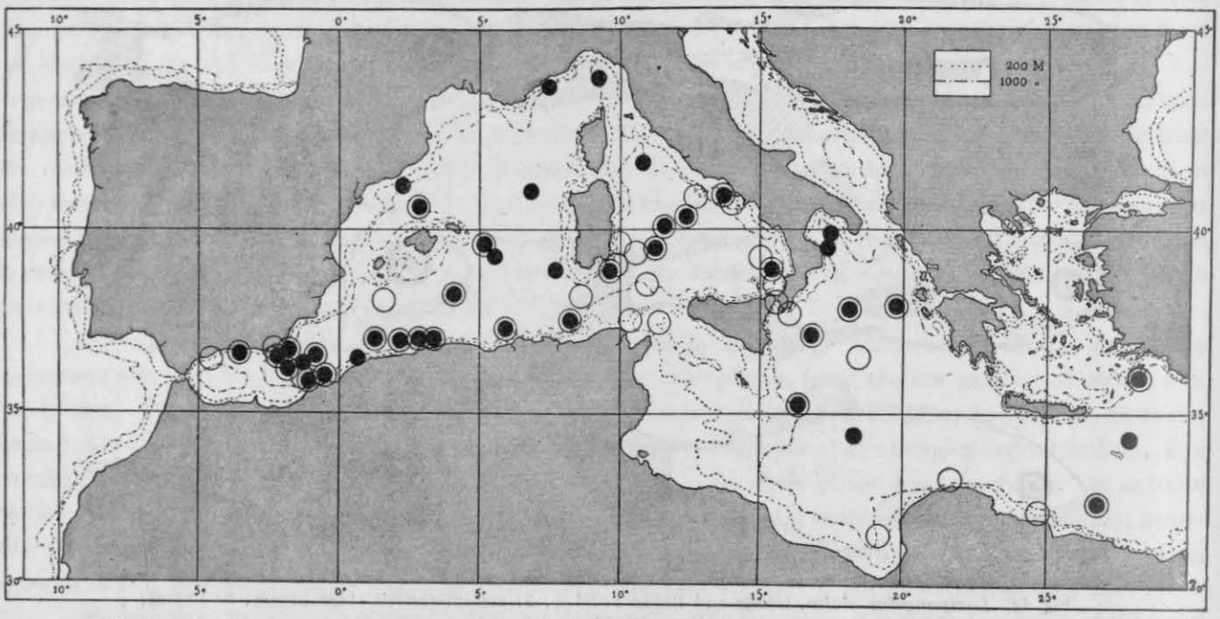

Fig. 43. Distribution of *Lampanyctus alatus*, Goode and Bean, according to the investigations of the "Thor"; ● adult stages, ○ postlarval stages.

Length of the caudal as follows:

In specimens of abt. 10 mm, C. is 2 mm long.
— — 20 - — 4 - —
— — 30 - — 7 - —
— — 40 - — 8.5 - —

Distribution. *Lampanyctus alatus* is known from the Atlantic and Indian Oceans. In the Mediterranean, the distribution will be seen from the chart, and from the following table for numbers of adults and postlarval stages taken in the different areas.

Area	Alboran Sea	Balearic Sea	Tyrrhenian Sea	Adriatic Sea	Ionian Sea	Levantine Sea	Ægean Sea
Adults	65	203	21	0	16	5	0
Postlarvæ	52	82	29	0	33	6	0

Among the richer stations, the following may be noted.

St. 46	(Balearic Sea)	91 adults
- 47	—	16 —
- 50	—	35 —
- 107	(Alboran Sea)	32 —
- 47	(Balearic Sea)	16 postlarvæ
- 206	—	10 —
- 107	(Alboran Sea)	16 —
- 143	(Ionian Sea).....	10 —

On considering the quantities taken in the different hauls, we are led to the conclusion that the species must be one of sociable character. It is found, like the remaining *Scopelids*, over great depths; this applies, as often noted in other cases, especially to the adults.

Metres of wire out	Winter		Summer			
	Dec.—Feb.		June—July		Aug.—Sept.	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	8	5	4	3	17	8
65	124	28	1	2	"	"
300	23	5	62	12	18	8
1000—2000 ...	2	0.4	14	2	14	4

Vertical distribution of the adult stages will be seen from the table here, where we find the same state of things as already noted for most of the species in the Mediterranean, *viz.* that it lives deeper down in midsummer than in winter and late summer. Nearly all the specimens were taken in night hauls, and the species is thus, at this part of the 24 hours, not among those living at the deeper levels.

Vertical distribution of the mature individuals over 30 mm will be seen from the following figures:

Metres of wire out	No. of spec. > 30 mm	No. of positive hauls
25	7	4
65	16	2
300	46	14
600	2	2
1000—2000	12	8

It will be noted that the species is most frequently taken with 25—300 m. w., i. e. within abt. 150 metres from the surface, though some few were occasionally taken in deeper hauls. The smallest adolescent stages under 15 mm are also taken for the most part with 25—300 m. w. (24 out of a total 25 specimens under 15 mm). Of larger postlarvæ and metamorphosis stages, the material includes only 2 specimens over 10 mm; both were taken with 2000 m. w. The present small material thus gives no very distinct indication of any ontogenetic migration. In this and the following species, some stages at any rate appear to be lacking between the largest postlarvæ and the smallest adolescents, which might seem to suggest that the stages in question are to be found deeper down than the "Thor" generally fished.

The maximum for vertical distribution of the postlarval stages seems on the whole to lie somewhat deeper for this species than in the case of several others, especially in winter. The table here will give an idea of this. Nearly all the specimens taken in summer with 65 m. w. are from a single haul.

Metres of wire out	Winter		Summer	
	No. of spec.	No. pr. hour	No. of spec.	No. pr. hour
25	8	2	9	5
65	23	3	17	23
300	29	12	76	7
> 500	4	2	24	2

The material does not suggest that the postlarvæ undertake any day-to-night migration, or that the different postlarval stages prior to metamorphosis live at different depths. The adult material likewise affords no indication of any day-to-night migration. Only 11 specimens were taken in 5 day hauls; these are of all sizes, small and large, and none were taken with less than 300 m. w.

Size in mm	Dec. 1908	Jan. 1909	Feb. 1909	June 1910	July 1910	Aug. 1910	Sept. 1910
45							
	..	..	..	..	..	1	
40	..	..	..	2	1		
	..	..	..	3			
	..	..	1	5	1	3	2
	..	..	4	1	1	..	1
	..	..	2	2	3	2	1
35	..	..	5	4	..	..	1
	..	..	4	5	..	..	7
	..	..	4	4	1	1	
	..	..	2	4	..	..	1
	..	..	2	..	1	2	
30	..	..	..	1	1		
	..	..	4	..	2		
	..	1	1	..	..	1	
	..	1	5	1			
	1	..	5	1	2	1	
25	..	..	7	1	..	..	1
	..	1	2	..	1		
	..	..	6	2	..	1	
	1	..	7	1	1	1	
	1	..	4	2	..	1	
20	1	2	7	2	2		
	..	4	6	3	1	1	
	..	2	6	2	2	..	1
	..	3	17	7	..	2	3
	..	5	12	7	1	1	4
15	..	..	22	2	..	..	7
	..	..	13	1	..	..	1
	..	..	8	..	..	..	2
10							

Propagation. *Lampanyctus alatus* is one of the smaller species among Mediterranean *Scopelids;* in any case, we have no specimens from this sea over 41 mm (ZUGMAYER 1911: 43 mm); it seems nevertheless that this species (or *L. pseudoalatus*, sp. n.) can attain a size considerably beyond this, and thus also an age of several years, as BRAUER (1906) mentions a specimen of 93 mm. As will be seen from the accompanying table for sizes and seasons, the species in the Mediterranean falls into two fairly distinct size groups (0 and I). As mentioned, there are only one or two of the postlarvæ over 10 mm (taken in June); the rest are under 10 mm, and most of them again below 7 mm (161 out of a total 202). The quantities for the various months are as follows:

December	January	February	June	July	August	September
11	10	51	40	41	34	15

Apparently then, a certain amount of spawning takes place all the year round, but since the species divides, as mentioned, into two distinct groups, we must presume that the spawning season is more particularly relegated to the first half of the year.

Maturity is attained at a length of abt. 30 mm. The largest ovaries, in specimens of abt. 40 mm, were abt. 8.5 mm long and abt. 2 mm broad. The following numbers of large eggs, greatest diameter 0.40—0.45 mm, were counted in two specimens:

Length of fish:	No. of large eggs:
39 mm (September)	(483 + 472) = 955.
30 " (July)	(339 + 379) = 718.

LAMPANYCTUS CROCODILUS (Risso).

Vert.: *36, 37*; D: 13, 14, *15*; A: 16, *17, 18*; P: 13, *14*; V: 8.

Material. Of this species, we have 1146 specimens from the Mediterranean and the Sea of Marmora, by far the greater part being postlarval stages, *viz.* 1087, as against only 59 adults. The bulk of the material was taken by the "Thor", but one adult specimen and 23 postlarvæ were collected at Messina in March 1911. From the Atlantic, I have had a smaller quantity of material.

Literature. *Lampanyctus crocodilus* was described from the Mediterranean by RISSO in 1810, and is one of the more generally known species in that sea. From the Atlantic, it is best known through HOLT and BYRNE's work (1911). As mentioned above, *Lampanyctus alatus* has probably often been confused with this species in the Mediterranean. See also BRAUER (1906).

Postlarval characters. *19 mm* (24 mm with caudal). This stage must be regarded as coming immediately before metamorphosis. Strongly built, fairly elongated in shape. The pectoral is here losing its larval ap-

pearance, but has, like the other fins, the specific number of rays fully formed, though the fins have not yet attained their subsequent shape. Eye circular, relatively smaller than in the younger stages.

Occipital pigment: an unpaired melanophore. Abdominal pigment, as faint internal pigment. Præanal pigment on the anal papilla. Dorsal pigment: a large unpaired melanophore between the dorsal and the adipose fin; in addition, the lateral pigment mentioned below as situate above the pectoral extends right up to the dorsal part of the body. This pigment, which follows the myotomes, lies above, behind and below the pectoral fin, and is very characteristic in this species. On the pectoral itself, and at base of same, there are several melanophores. Of photophores, only *Brr.*

14 mm (17). This stage has exactly the same pigmentation as the foregoing. Shape more larval, apparent especially in the shorter and heavier build, larval apparance of the fins, large eye, etc.

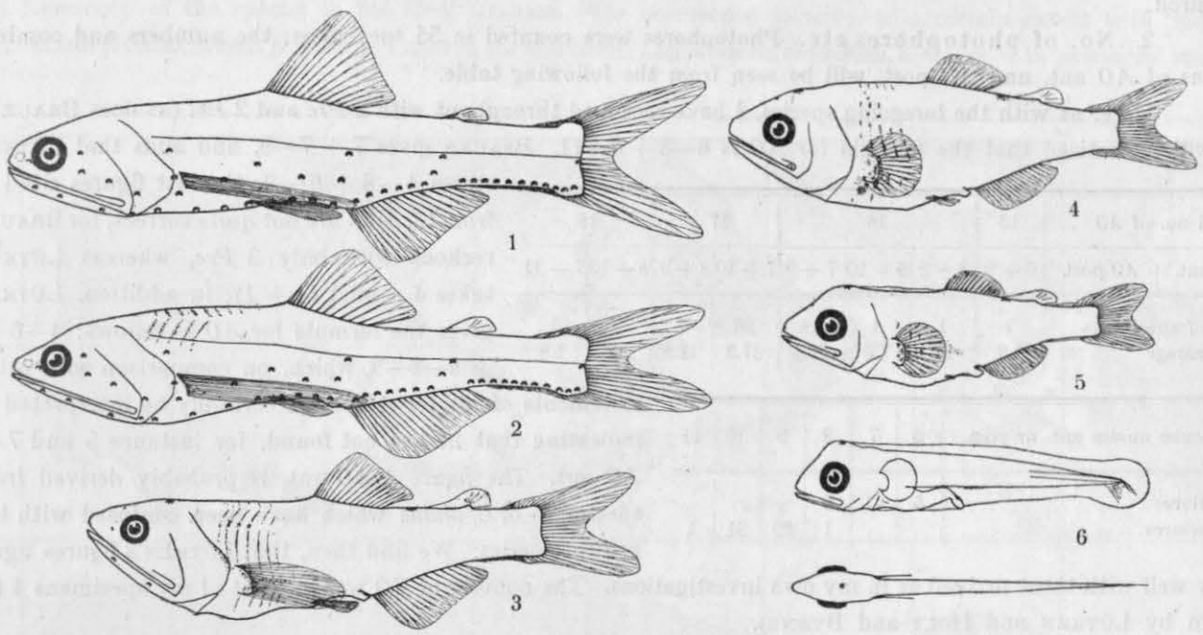

Fig. 44. *Lampanyctus crocodilus* (Risso). 1: ad. ♂; 2: 23.5 mm (adolescent stage with remains of postlarval pigment); 3: 19 mm; 4: 14 mm; 5: 8 mm; 6: 5.5 mm (lateral and dorsal view).

8 mm (9.5). Pigmentation in the main as in foregoing stages, but the lateral pigment much fainter, and may be almost obliterated; the large dorsal melanophore between the dorsal and adipose fins, however, is distinct. Remains of the larval marginal fin-fold; rays of the dorsal not fully formed at the back. Ventral only indicated.

5.5 mm. Tail diphycercal. Larval marginal fin-fold intact. Only slight indications of the caudal fin and forepart of base of anal. The pectoral distinct, as always, even in the smallest stages. Of the melanophores, generally only the unpaired occipital and that on the anal papilla.

The typical metamorphosis stage of this species is not represented in our material; there are, however, some few slightly older stages, of more adult appearance. One of these (taken with 2000 m. w.) is shown above; it exhibits distinct remains of the postlarval pigment. Several other smaller adolescent stages likewise have the suprapectoral pigment distinct. Metamorphosis must take place at between 19 and 22 mm, as the postlarva of 19 mm shown above (likewise taken with 2000 m. w.) exhibits all signs of approaching metamorphosis. Otherwise, the largest postlarvæ are 17 mm long.

Fin rays and vertebræ were counted, and found in accordance with the values for adult stages.

It is apparently this postlarva which is figured by Holt and Byrne 1911 (fig. 8, Pl. I) and described on p. 29—30 as "Scopelid larva, R. 2". I would here observe, however, that I have never met with any Mediterranean

specimen having the ventral melanophore at the anal fin, as shown in HOLT and BYRNE's figure; on the other hand, I have found it, though fainter, in specimens from the waters near Ireland. The *Scopelid* larva described by HOLT and BYRNE (1911) on p. 27—28, and shown in fig. 2—7, Pl. I, is, as already mentioned, a postlarva of *Myctophum punctatum*.

Adult characters.

1 No. of vertebræ. Vertebræ were counted in 23 specimens from various stations in the western basin and the Ionian Sea; of these, 13 had 36 vertebræ, and 10 had 37. From the Atlantic, only 9 specimens were examined for this character; 5 had 37 and 3 had 38. These few counts thus seem to suggest that the number of vertebræ in the Atlantic is generally higher than in the Mediterranean. Further material will however, here be required.

2. No. of photophores etc. Photophores were counted in 55 specimens; the numbers and combinations of *AO* ant. and *AO* post. will be seen from the following table.

Here, as with the foregoing species, I have reckoned throughout with 2 *Prc* and 2 *Pol* (as does BRAUER). It will be noticed that the formula for *AO* is 6—8 + 8—11. BRAUER gives 7 + 7—9, and adds that LÜTKEN states 4—8 + 6—9; the last figures cited as from LÜTKEN are not quite correct, for BRAUER reckons with only 2 *Prc*, whereas LÜTKEN takes 4 caudal (3 + 1); in addition, LÜTKEN gives the formula for *AO* as follows: 4—6—8 + 6—8—9, which, on comparison with other statements of his for *AO*, must certainly be interpreted as indicating that he has not found, for instance 5 and 7 as *AO* ant. The figure 4 *AO* ant. is probably derived from specimens of *L. alatus* which have been confused with the present species. We find then, that LÜTKEN's figures agree very well with those arrived at in my own investigations. The number of *VO* was in most of my specimens 4 (as given by LÜTKEN and HOLT and BYRNE).

Total no. of *AO* ...	15	16			17		18	
AO ant. + *AO* post.	6 + 9	8 + 8	6 + 10	7 + 9	7 + 10	8 + 9	8 + 10	7 + 11
No. of specimens ..	1	1	4	14	26	7	1	1
Percentage	1.8	1.8	7.3	25.4	47.3	12.8	1.8	1.8

Maculæ anales ant. or post.	6	7	8	9	10	11
anteriores	5	41	9			
posteriores.....	..	..	1	22	31	1

I would here further note that the luminous scales at the anterior margin of the adipose fin furnish an excellent means of distinguishing the present species from *Lampanyctus gemmifer*, GOODE and BEAN. Other characters by which these species are generally distinguished have often proved indistinct; the number of photophores on the cheek, for instance, is variable; in *Lampanyctus crocodilus*, I have found, besides the normal value (3) also 2, 1 and 0, at any rate on the one side, while in *Lampanyctus gemmifer*, I have found 2, 1 and 0, at any rate on the one side. The luminous scale at the adipose fin, however, is always present, and is found even in the smallest adult stages. (I have examined abt. 100 specimens of this species).

The length of the caudal appears to be as follows:

In specimens of abt. 23 mm the length of C is abt. 6—7 mm
— — 30 - — — — 8 -
— — 40 - — — — 9 -
— — 50 - — — — 11 -
— — 60 - — — — 12 -
— — 70 - — — — 15 -

Distribution. As mentioned above, *Lampanyctus crocodilus* is found in the Atlantic (LÜTKEN, HOLT and BYRNE, ZUGMAYER). In the Mediterranean, it is best known from the Strait of Messina. It is, however, found in most parts of the Mediterranean, and even in the Sea of Marmora. Its distribution will be seen from the accom-

panying chart, and from the table below showing number of adults and postlarval stages taken in the different areas of the Mediterranean.

Area	Alboran Sea	Balearic Sea	Ligurian Sea	Tyrrhenian Sea	Ionian Sea	Adriatic Sea	Levantine Sea	Ægean Sea	Marmora
Adults, no. of spec...	22	27	0	2	5	1	0	0	1
— no. pr. hour..	4	3	0	1	2	1	0	0	2
Postlarvæ, no. of spec.	512	277	152	97	9	0	0	0	10
— no. pr. hour	39	18	22	4	7	0	0	0	7

In this species, where the adults are so few, the figures for postlarvæ tell us more about the distribution and frequency of the species in the Mediterranean. The occurrence coincides to a certain extent with that of *Myctophum glaciale*, which is likewise found in the Marmora; *Lampanyctus crocodilus*, however, is in postlarval stages

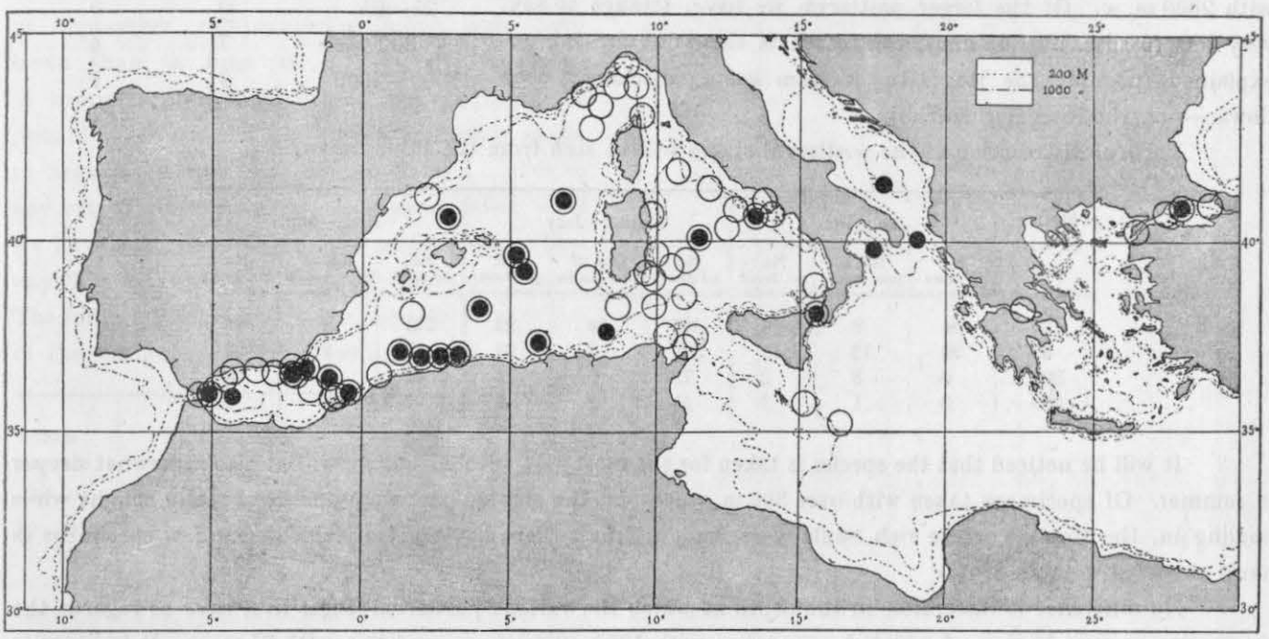

Fig. 45. Distribution of *Lampanyctus crocodilus* (Risso), according to the investigations of the "Thor"; ● adult stages; ○ postlarval stages.

found in a greater part of the western basin than *M. glaciale*. Finally, one or two of the richest stations may be mentioned. Of adult stages, no great numbers were ever taken in any single haul; where several were taken in one haul, they were the smallest adult stages. This may possibly be due to that the species is probably not of a sociable character, or to its extreme swiftness of movement, which enables it to elude the nets.

Adult stages	St. 108 (Alboran Sea)	8	spec.
—	- 118 (Balearic Sea)	5	—
Postlarval stages.	- 106 (Alboran Sea)	88	—
—	- 107 —	75	—
—	- 225 —	97	—
—	- 218 (Balearic Sea)	86	—
—	- 123 (Ligurian Sea).....	86	—

The species is found over great depths. As with most other species spawning in the Alboran sea in winter, so also here we find a number of the postlarvæ in shallower water in the northern part of this area during the winter months (see under *Myctophum glaciale* p. 40).

As to vertical distribution of the adult stages, very little can be said from the small material of these stages. The table shows that the species keeps to deep water, especially in summer.

Metres of wire out	Winter		Summer	
	No. of ad.	No. of hauls	No. of ad.	No. of hauls
25	0	0	0	0
65	5	3	4	1
300	5	5	19	8
600	0	0	1	1
1000—2000	2	2	18	10

Of specimens over 45 mm we have only 9; most of these were taken with 65 and 300 m. w., two with 1200 m. w. The smallest adolescent stages, under 25 mm, are all found fairly deep down, as will be seen from the following.

There is only one postlarva which can be reckoned as at all near metamorphosis; this specimen was, as already mentioned, taken with 2000 m. w. Of the larger postlarvæ we have, strange to say, very few (6 spec. over 15 mm); the reason of this is at present unexplained (possibly the stages in question keep particularly deep down — cf. the foregoing species).

Metres of wire out	No. of spec. < 25 mm.	No. of hauls
25—65	0	0
300	7	4
1000—2000	9	7

Vertical distribution of the postlarval stages will be seen from the table below.

Metres of wire out	Jan.—Feb.			June—July			Aug.—Sept.		
	No. of spec.	No. of pos hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour	No. of spec.	No. of pos. hauls	No. pr. hour
25...	84	8	9	125	14	22	221	6	88
65...	90	12	11	325	8	93	11	2	22
300...	6	3	2	72	9	14	42	8	14
>300...	3	1	3	44	12	4	7	3	4

It will be noticed that the species is taken for the most part with 25—65 m. w. but also somewhat deeper in summer. Of specimens taken with over 300 m. w., by far the greater part were doubtless really caught while hauling in, the stations where rich hauls were made at the surface having also yielded some few specimens in hauls made at greater depths.

No difference is discernible in the depth at which the various postlarval stages live, save as regards the six specimens over 15 mm, of which 4 were taken with 1200—2000 m. w. and two with 65 m. w. It is likewise impossible to discern any day-to-night movement, as postlarvæ were taken not only in night hauls but also in day hauls with 25—65 m. w.

The adult stages were nearly all taken in night hauls, only five specimens by day; these last were taken with 2000 m. w. and measured only 23—25 mm, i. e. recently metamorphosed stages.

Propagation. Of all known *Scopelids*, the present species is the one attaining the greatest length, specimens of 200—300 mm being known from the Mediterranean. The largest individual in our Mediterranean material is 87 mm[1]) otherwise there are, as mentioned, very few large specimens at all in the material.

Nothing can be said as to the time when maturity is attained, or as to number of eggs in the ovaries, none of the specimens being suitable for investigation of this point. The rich material of postlarval stages however, seems to throw some light on the question of spawning and fertility.

In all probability this large species will be found to have an even greater number of eggs in the ovaries than any of the others here dealt with; this would appear likely, for instance, from the large number of postlarval stages in comparison with the small number of adults, and from the size of the adult specimens known.

[1] From the Atlantic we have specimens up to 129 mm (excl. caudal).

On investigating the numbers of postlarvæ in the three months February—June—September, when the "Thor" was fishing in nearly the same waters, we find an increase towards the last months, as will be seen from the following figures:

Month	No. of postl.	No. pr. positive hour
February	118	14
June	355	35
September	261	50

It is of course natural to suppose that the spawning in the Mediterranean should be at its height some way on in the summer; here, however, it should be borne in mind that there are in September comparatively fewer large postlarvæ than in June (cf. p. 57). The species is of common occurrence in the Bay of Cadiz, so possibly this sudden appearance of smaller stages in September may have its origin here. It is at any rate hardly reasonable to suppose, after what we have seen elsewhere in the present work, that any *Scopelid* should spawn more than once a year. The following table shows the respective quantities of the various sizes at different seasons:

Size in mm.	Feb.		June		Sept.	
	No. of spec.	%	No. of spec.	%	No. of spec.	%
10—19...	0	0.0	83	23.4	11	4.2
7—10...	20	17.0	156	43.9	63	24.1
<7...	98	83.0	116	32.7	187	71.7

The present species was, as mentioned, also taken in the Sea of Marmora. It does not however, appear to be very numerous there; we have only one large specimen (52 mm, taken with 1200 m. w.) and 10 postlarvæ (65—100 m. w.) from this water.

Size in mm.	Dec. 1908	Jan. 1909	Feb. 1909	March 1911	June 1910	July 1910	Aug. 1910	Sept. 1910
87	..	..	..	1				
69	..	..	..		1			
55	..	..	1	..	1			
	..	..	..	..	..	..	1	
50								
	..	..	2					
	1	..	1					
45	..	..	..	..	..	..	..	1
	1	..	1					
	..	1						
40								
	..	..	1					
	1							
35								
	1	..	..	..	1	..	..	1
	2	..	..	..	..	..	1	
	..	..	1					
30	..	..	..	..	1			
	..	..	..	..	1			
	..	..	1	..	..	1	1	1
	..	..	..	..	5	..	..	1
	..	..	1	..	1			
25	..	..	..	..	5	..	1	1
	..	..	..	..	5	..	1	1
	..	..	..	..	6	..	2	
	..	..	..	..	1			
20								

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D. List of stations etc.

Abbreviations etc.

Y 200 Young-fish trawl, 200 cm in diam. at opening.
Y 330 — , 330 - — —
C 200 Ring-trawl, 200 cm in diam. at opening.
C 130 — , 130 - — —
S 100 Stramin-net, open, conical, 100 cm in diam. at opening.

Myct. Ris. = Myctophum Rissoi.
— gl. = — glaciale.
— Ben. = — Benoiti.
— Hyg. = — Hygomi.
— pun. = — punctatum.
— Hum. = — Humboldti.
— Coc. = — Coccoi.
Diaph. Gem. = Diaphus Gemellarii.
Diaph. Dof. = Diaphus Dofleini.
— Raf. = — Rafinesquei.
— Hol. = — Holti.
Lamp. mad. = Lampanyctus maderensis.
— elg. = — elongatus.
— alt. = — alatus.
— cro. = — crocodilus.

The last column shows the number of specimens and their length (in parenthesis).
*) indicates uncertainty as to length of wire, or hour, at which the specimens referred to were taken.
The names Ben. and Hyg. in parenthesis denote that postlarvæ of these species were taken; the number of postlarvæ here likewise in parenthesis. Where the name is not in parenthesis, this denotes that adult stages of these species were taken; postlarvæ may, however, also have been taken at the same time, and the number of these will then be set in parenthesis.
For further information (as to temperature, salinity, etc.) reference should be made to the Introduction of the present Report, Vol. I, 1912.

Winter cruise. Mediterranean (Eastern Basin).

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Mysticetum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
10	15/12 08	5⁰⁰ am	N 37°21′	E 16°45′	>2100	Y 200	25	60	(Ben) (Hyg)	(2)										
									Raf	..	2									
»	»	6¹⁰ am	»	»	»	Y 200	65	60	(Ben) (Hyg)	(66)	(40)	(5)								
									Dof	..	1	..	..	1						
									Raf	4	4									
									mad	..	3	3								
									alt	4	1									
»	»	8⁰⁰ am	»	»	»	C 130	300	30												
»	»	9³⁰ am	»	»	»	Y 200	1200	60	gl	..	..	..	..	1						
									Ben (Hyg)	(1)	(1)	(2)	2	1						
									Hum	..	..	..	..	..	1					
									Hol	..	..	..	..	1						
									Raf	..	..	1								
									mad	..	1	..	2	11						
									alt	..	1									
»	»	3⁴⁵ pm	»	»	»	Y 200	600	60	(Ben) (Hyg)	(3)	(4)									
									Dof	..	..	1	..	..	1					
									Hol	..	..	..	4							
									Raf	..	..	5								
									alt	..	..	..	..	2						
11	16/12 08	4⁰⁰ am	36°57′	18°16′	>3700	Y 200	25	60	Ben (Hyg)	(104)	(4)	..	1	2						
									Hum	..	1									
									alt	3										
»	»	5²⁵ am	»	»	»	Y 200	65	60	(Ben) (Hyg)	(23)	(36)									
									Hum	..	1									
									Raf	1	1									
									mad	..	1	1								
									alt	2										
»	»	7⁰⁰ am	»	»	»	Y 200	300	120	(Ben) (Hyg)	..	..	(2)								
									Hol	..	..	2								
									Raf	..	..	11	1	..	..	..	..	..	..	1(54) 1(56)
									mad	..	..	..	..	3						
»	»	9³⁰ am	»	»	»	Y 200	1000	180	Raf	..	..	4								
12	19/12 08	11⁴⁰ am	39°34′	17°17′	1060	Y 200	300	60												
»	»	1⁰⁰ pm	»	»	»	Y 200	65	30	(Ben) (Hyg)	(1)	(4)									
									Hum	..	..	..	1							
									Raf	..	1									
»	»	2¹⁵ pm	»	»	»	Y 200	1000	45	gl	..	..	..	..	5	1					
									Hol	..	..	2								
									mad	..	..	..	..	1	2					
									alt	..	..	..	..	..	1					
13	19/12 08	5³⁵ pm	39°43′	17°30′	>1200	Y 200	300	60	(Ben) (Hyg)	..	(1)									
									Hum	..	..	1	..	1	1					
									Hol	..	..	1	1	1	1					
									Raf	..	..	5								
									mad	..	..	..	..	2						
									cro	..	..	..	..	..	..	..	..	1		

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haulin minutes	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	∧ 50
13	19/12 08	7[05] pm	39°43′	17°30′	1200	Y 200	1000	60	(Ben)	..	(1)	(2)								
									(Hyg)											
									Hol	..	..	1								
									Raf	..	..	1								
									mad	..	..	..	..	1						
»	»	8[50] pm	»	»	»	Y 200	65	60	gl	..	..	..	..	..	1					
									(Ben)											
									(Hyg)	..	(10)	(4)								
									Hum	..	2	1								
									Raf	..	2	4								
									mad	..	..	..	..	5	..	..	1			
									cro	..	..	..	..	..	..	1	1	..	1	
									alt	..	..	..	..	1						
»	»	10[15] pm	»	»	»	Y 200	15	60	Hyg	..	..	..	1							
									pun	..	..	..	..	1	..	..	..	..	..	1(57)
									Hum	..	..	..	..	3	11					
									mad	..	..	..	1	9	1	..	..	..	..	1(52)
14	21/12 08	5[00] am	41°24′	17°45′	1125	Y 200	65	60	gl	..	..	..	..	..	..	..	1			
									(Ben)											
									(Hyg)	..	(4)									
									pun	..	..	..	..	..	..	1				
									Hum	..	1									
									mad	..	..	..	..	8	2	1	1	..	1	
									cro	..	..	..	..	..	..	1				
»	»	6[30] am	»	»	»	Y 200	300	60	gl	..	..	..	..	1						
									Hol	..	..	..	2							
»	»	8[20] am	»	»	»	Y 200	1000	90	gl	..	..	..	1	3						
									Dof	..	..	..	..	..	..	..	1			
									Hol	..	..	3	3							
									Raf	..	..	2								
									mad	..	..	..	..	1						
15	22/12 08	1[30] am	40°04′	19°06′	1125	Y 200	65	60	(Ben)											
									(Hyg)	(4)	(53)	(12)								
									Hum	..	1									
									Raf	..	2									
									mad	..	..	..	..	1	..	1	..	..	1	
»	»	2[40] am	»	»	»	Y 200	25	60	(Ben)											
									(Hyg)	(7)	(10)	(2)								
									Hum	..	..	..	..	..	2					
									Raf	..	1	..								
									mad	..	..	..	..	1	2	1				
* »	»	5[20] am	»	»	1000	Y 200	1400	60	gl	..	..	..	..	1						
									Ben	..	..		1							
									Hyg	..	..	(1)	1							
									Raf	..	..	4								
									mad	..	..	..	..	4	1	1				
									cro	..	..	..	..	..	..	1				
* »	»	8[00] am	»	»	»	Y 200	1400	60												
16	22/12 08	8[35] pm	39°34′	20°01′	70	Y 200	65	30	(Ben)											
									(Hyg)	..	(14)	(10)								
18	30/12 08	7[00] pm	37°51′	23°14′	220	Y 200	25	60				•								
»	»	9[30] pm	»	»	»	Y 200	300	60	(Ben)											
									(Hyg)	..	..	(2)								
20	5/1 09	3[10] am	37°48′	15°49′	>1300	Y 200	25	60	Ben	..	..	..	2	2						
									Hum	..	..	..	..	..	1					
21	5/1 09	11[50] pm	37°51′	15°21′	>500	Y 200	10	30												

Mediterranean (Western Basin).

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes.	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
22	7/1 09	8⁰⁰ pm	38°50′	15°18′	> 750	Y 200	25	30												
»	»	8⁴⁵ pm	»	»	»	Y 200	200	30	Ben	(26)	(3)	1	..	..	..	1				
									Hyg			1								
									Hum	..	1	..	..	..	..	..	..	..	..	1 (80)
									Raf	..	..	5								
									mad	..	2	..	..	1						
									cro	6										
									alt	2	..	..	5	1						
23	15/1 09	11⁵⁰ pm	40°34′	13°24′	>1800	Y 200	25	30	(Ben)											
									Hyg	..	(3)	..	1							
									mad	..	1	..	..	1						
24	16/1 09	7⁵⁰ am	40°14′	12°23′	>3700	Y 200	65	30	(Ben)											
									(Hyg)	(14)	(16)	(3)								
									elg	..	1									
									cro	24	6									
									alt	2										
* »	»	9⁰⁰ am	»	»	»	Y 200	300	60	Ris	1	5									
									(Ben)											
									(Hyg)	(3)	(2)									
									Hum	..	1	1								
									Dof	..	..	..	..	..	..	1				
									Gem	..	1									
									Hol	..	..	..	1	1						
									Raf	..	..	1								
									alt	..	..	..	1	1						
»	»	11³⁰ am	»	»	»	C 130	3000	60												
»	»	2¹⁰ pm	»	»	»	Y 200	600	60	(Ben)											
									(Hyg)	..	(1)									
* »	»	9¹⁰ pm	»	»	»	Y 200	300	30												
»	»	10⁰⁰ pm	»	»	»	Y 200	25	30	(Ben)											
									Hyg	..	(2)	1								
									Hum	..	1	..	..	..	..	..	1			
									Raf	..	..	1								
									mad	..	..	..	..	..	1					
									elg	1										
									alt	..	..	..	4							
»	»	11¹⁵ pm	»	»	»	Y 200	1600	240	Ris	..	1									
									(Ben)											
									Hyg	..	(1)	(1) 1								
									Raf	..	..	1								
									mad	..	..	..	1							
									alt	..	..	..	1							
»	17/1 09	4³⁰ am	»	»	»	Y 200	65	120	Hum	..	4									
									Dof	1	1	..	..	1						
									mad	..	1	..	..	2	3					
									alt	..	..	..	..	..	1					
»	»	7¹⁵ am	»	»	»	Y 200	300	120												
25	17/1 09	4⁴⁰ pm	40°34′	13°24′	>1800	Y 200	65	30	(Ben)											
									(Hyg)	..	(2)	(3)								
									cro	1	1									
»	»	5⁴⁰ pm	»	»	»	Y 200	300	60	(Ben)											
									Hyg	..	(2)	(2)	3							
									Hum	..	..	..	..	..	..	..	1			
									Hol	..	..	..	1	1						
									Raf	..	..	2								
									cro	..	..	..	..	..	..	..	..	1		

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes.	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	∧ 50
26	8/1 09	0^{45} am	40°40′	13°59′	560	Y 200	65	60	(Ben)	..	(17)	(13)								
									(Hyg)											
									Hum	..	2									
									Dof	..	2									
									Gem	1	2									
									alt	1										
»	»	2^{15} am	»	»	»	Y 200	300	60	Ris	..	4									
									(Ben)											
									(Hyg)	(1)	(7)	(26)								
									Dof	..	1									
									Gem	5	1	2								
									Raf	..	..	9	1							
									cro	..	..	1								
»	19/1 09	0^{50} am	»	»	»	Y 200	150	180	(Ben)											
									(Hyg)	(2)	(14)	(12)								
									Hum	..	4									
									Dof	..	1									
									Gem	4	4	1								
									Raf	1										
									mad	..	1									
									cro	..	2									
									alt	2										
»	»	4^{20} am	»	»	»	Y 200	25	120	Ris	..	2									
									(Ben)											
									(Hyg)	(2)	(15)	(10)								
									Hum	..	3	..	..	..	..	..	..	..	..	1 (58)
									Gem	6	8	1								
									mad	..	..	1								
									cro	3	3									
									alt	..	1									
»	»	6^{40} am	»	»	»	Y 200	300	180	Hum	..	2	2	1							
27	19/1 09	0^{45} pm	40°58′	13°49′	90	Y 200	200	30												
»	»	3^{00} pm	»	»	»	Y 200	130	30												
»	20/1 09	2^{30} am	»	»	»	Y 200	25	180	(Ben)											
									(Hyg)	(1)	(10)	(21)								
									pun	..	..	..	..	..	..	..	..	..	..	1 (60)
									Hum	..	3	1	..	..	..	..	..	..	..	1 (75)
									Gem	3	3									
									elg	..	1									
									cro	..	2									
»	»	6^{00} am	»	»	»	Y 200	65	120	(Ben)											
									Hyg	(2)	(14)	(4)	1							
									Hum	..	..	..	..	..	..	..	..	..	..	1 (87)
									Gem	..	3									
									cro	..	1									
28	19/1 09	5^{00} pm	40°53′	13°43′	600	Y 200	1000	60	(Ben)											
									Hyg	..	(1)	(7) 2								
									Hum	..	..	1								
									Raf	..	..	1								
»	»	6^{40} pm	»	»	»	Y 200	400	30	(Ben)											
									(Hyg)	..	..	(4)								
									Gem	1										
									Hol	..	..	..	1	3	1	1				
									Raf	..	..	3								
									mad	..	..	..	..	..	..	..	..	..	1	
»	»	7^{30} pm	»	»	»	Y 200	25	60	Ris	..	4									
									(Ben)											
									(Hyg)	..	(4)	(5)								
									Hum	..	1	1								
									mad	..	..	..	..	1	1					

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	V 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	Λ 50
28	19/1 09	9⁰⁰ pm	46°53′	13°43′	600	Y 200	200	30	(Ben)											
									(Hyg)	..	(2)	(2)	1							
									Hum	..	1									
									Gem	..	2									
									Raf	..	..	2								
									mad	..	..	..	1	1						
»	»	10⁰⁰ pm	»	»	»	Y 200	100	60	(Ben)											
									Hyg	(1)	(3)	(14)	1							
									Gem	2	1									
									Raf	..	..	1								
									mad	..	..	..	..	1	2	..	1			
									cro	..	1									
									alt	..	..	..	1	1						
»	»	11⁵⁰ pm	»	»	»	Y 200	65	120	(Ben)											
									(Hyg)	(2)	(23)	(10)								
									Hum	..	..	3								
									Gem	2	2									
									alt	..	1									
29	20/1 09	2¹⁵ pm	40°47′	12°55′	1550	Y 200	1650	60	Ben	..	..	..	1							
									Hyg	..	..	1								
									Dof	..	..	..	..	..	..	1				
									Raf	..	..	1								
»	»	7²⁰ pm	»	»	»	Y 200	200	60	(Ben)											
									(Hyg)	..	(5)	(48)								
									Dof	..	1									
									Gem	1	2									
									Hol	..	..	..	..	1	1					
									Raf	..	1	6								
									mad	..	..	..	..	1						
									elg	..	1									
									cro	..	..	1								
									alt	1										
»	»	8⁴⁰ pm	»	»	»	Y 200	65	30	(Ben)											
									(Hyg)	(3)	(7)	(1)								
									Hum	..	1	1								
									Gem	..	1									
									mad	..	..	..	..	..	..	..	..	..	..	1 (52)
»	»	9³⁰ pm	»	»	»	Y 200	600	60	(Ben)											
									(Hyg)	..	..	(3)								
									pun	..	..	..	..	..	1					
									Hum	..	..	2								
									mad	..	..	..	1							
30	21/1 09	5³⁰ am	41°15′	11°55′	>1800	Y 200	65	60	(Ben)											
									(Hyg)	..	(5)	(10)								
									Hum	..	2	2								
									Gem	1	1									
									mad	..	..	1	..	1	2					
									elg	2										
									cro	4	1									
»	»	7¹⁰ am	»	»	»	Y 200	300	60	Ris	1	2									
31	22/1 09	1²⁰ am	41°44′	10°52′	1420	Y 200	1400	60	(Ben)											
									Hyg	..	..	(2)	1							
									cro	3										
»	»	3⁰⁰ am	»	»	»	Y 200	600	30	(Ben)											
									(Hyg)	..	..	(3)								
									Hol	..	..	1								
									mad	..	..	..	..	2						
									alt	..	..	..	1	..	1					

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	V 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	Λ 50
31	22/1 09	3[30] am	41°44′	10°52′	1420	Y 200	200	30	gl	..	..	..	..	1						
									(Ben)	..	..	(3)								
									(Hyg)	..	..	1								
									Raf	..	..									
									cro	2										
»	»	4[30] am	»	»	»	Y 200	65	30	Hyg	..	..	..	1							
									mad	..	..	..	..	..	1	1				
33	23/1 09	6[30] pm	43°04′	9°35′	150	Y 200	65	30	(Ben)	..	(1)	(1)								
									(Hyg)											
									Hum	..	1									
									Dof	..	1									
									elg	1	5									
									cro	4	1									
34	23/1 09	4[35] am	43°27′	8°16′	>2000	Y 200	25	30	cro	4	1									
»	»	5[30] am	»	»	»	Y 200	65	30	cro	3	1									
»	»	6[35] am	»	»	»	Y 200	200	30	cro	4										
35	28/1 09	9[40] pm	43°36′	7°36′	>2000	Y 200	300	120	Ris	..	1									
									(Ben)	..	(2)	(3)								
									(Hyg)											
									pun	..	1									
									elg	..	1									
									alt	..	..	..	1							
»	»	11[35] am	»	»	»	Y 200	1600	120												
»	»	»	»	»	»	S 100	700	120	Raf	..	..	1								
									mad	..	..	..	..	..	1					
»	»	3[45] am	»	»	»	C 200	2500	90												
»	»	6[40] am	»	»	»	Y 200	200	60	(Ben)	..	..	..	..	..	..	..	1			
									pun	..	1	1								
									elg	5	21	3								
									cro	12	1									
»	»	7[55] am	»	»	»	Y 200	100	60	Ben	..	..	..	2							
									elg	3	6									
»	»	9[10] am	»	»	»	Y 200	25	60	Ben	..	..	..	4	..	1					
									elg	..	2									
36	30/1 09	5[35] am	42°49′	6°54′	>2000	Y 200	65	60												
»	»	6[50] am	»	»	»	Y 200	300	60	elg	2	3									
38	31/1 09	6[30] pm	40°45′	9°50′	105	Y 200	65	30	Ben	..	(1)	(1)	..	..	..	..	..	1		
									(Hyg)											
									Hum	..	..	1								
									elg	9	19	2								
»	»	7[10] pm	»	»	»	Y 200	25	30	elg	..	1									
									cro	6										
»	»	8[20] pm	»	»	»	Y 200	150	30	elg	..	1									
39	1/2 09	5[00] am	39°41′	10°02′	1750	Y 200	25	60	Hum	..	2									
									Gem	..	2									
									elg	2										
									cro	1										

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Mycotophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
39	1/2 09	6¹⁰ am	39°41′	10°02′	1750	Y 200	65	60	(Ben)											
									(Hyg)	..	(10)	(35)								
									Hum	..	1									
									Dof	..	3									
									Gem	..	2									
									elg	5	6									
									cro	1	3									
									alt	..	1									
»	»	7²⁰ am	»	»	»	Y 200	300	60	Ris	..	1									
									(Ben)											
									(Hyg)	..	(1)	(1)								
									Hum	..	1									
									elg	..	1									
									cro	2										
»	»	0³⁰ pm	»	»	»	Y 200	1000	120	Gem	1										
									Raf	..	..	..	1							
									elg	1	1									
40	1/2 09	9³⁰ pm	39°10′	9°40′	235	Y 200	65	30	Ben	..	..	..	..	2						
									pun	..	..	1								
									Hum	1	1	1								
									Dof	..	2									
									Gem	..	2									
									elg	..	3									
									cro	1										
42	1/2 09	9⁴⁰ pm	38°58′	9°37′	1120	Y 200	300	30	Ris	2	1									
									Ben											
									(Hyg)	(2)	(3)	(6)¹	..	..	..	1				
									pun	1	2	2								
									Hum	..	2	2								
									Gem	2										
									Raf	..	..	1	1	..	..	..	..	..	1	1 (57)
									elg	1	..	2								
									alt	..	4	..	..	3	..	..	1			
43	3/2 09	6¹⁵ am	38°14′	8°42′	>2000	Y 200	65	30	(Ben)											
									(Hyg)	..	..	(3)								
									pun	..	..	..	1							
									Hum	..	..	3								
									Dof	..	1									
									elg	6	8									
									cro	14	8									
									alt	3										
45	6/2 09	11²⁵ pm	37°28′	8°18′	2150	Y 200	300	30	Ris	1	8	2								
									gl	1	2	1	4							
									Ben											
									(Hyg)	..	(3)	(13)¹	2	1						
									pun	..	..	1	..	1						
									Hum	..	1									
									Dof	..	..	1								
									Raf	..	..	..	1							
									elg	..	2	4								
									cro	..	..	..	..	..	..	..	..	..	..	1 (55)
									alt	2	..	..	3	2	1	2				
»	7/2 09	0¹⁵ am	»	»	>2150	Y 200	65	30	Ris	..	1									
									Ben	..	..	..	6	13	3	1				
									Hyg	..	..	..	11							
									Dof	..	..	2	2							
									Gem	..	1									
									elg	..	..	1								

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	< 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	> 50
46	7/2 09	6[35] pm	37°17′	6°00′	>1930	Y 200	600	30	Ris	..	2	1								
									gl	..	..	..	1	1	1					
									Ben	..	..	(1) 5	3	1						
									(Hyg)											
									pun	..	1	..	1							
									Hum	..	..	1								
									Dof	..	..	..	2							
									Hol	..	..	..	1							
									elg	..	1									
									alt	..	1	..	..	..	1	1				
»	»	7[30] pm	»	»	»	Y 200	300	30	Ris	..	4									
									gl	..	4									
									(Ben)											
									(Hyg)	..	(1)	(3)								
									pun	..	5	1								
									Hum	..	..	2	2							
									Dof	..	..	1								
									Gem	..	1									
									Hol	..	..	..	2	1						
									elg	..	3									
									alt	1	2									
»	»	8[30] pm	»	»	»	Y 200	65	30	(Ben)											
									(Hyg)	(1)	(2)									
									pun	7										
									Dof	3	2									
									elg	2	1									
									cro	1										
									alt	2	..	6	43	9	14	6	5			
»	»	?	»	»	»	?	?	?	Ris	..	..	4								
									gl	..	..	..	1	4	1					
									Ben	..	..	4	13	9						
									pun	..	..	..	..	1						
									Dof	..	..	7	19							
									Hol	..	..	..	5	7	2					
									Raf	..	..	..	2							
									mad	..	..	..	..	1	2	7	2	..	..	1 (52)
									cro	..	..	..	..	..	..	..	..	1	2	
									alt	..	..	..	3	1	1	1				
47	10/2 09	10[20] pm	36°55′	3°12′	>2000	Y 200	65	30	gl	1	2	19	13	6	2					
									Ben	..	..	1	2	2	2	1	1			
									Hyg	..	..	..	1							
									pun	..	..	..	2							
									Hum	..	..	..	..	1						
									Dof	..	..	11								
									Hol	..	..	..	3	2						
									Raf	..	..	1								
									mad	..	..	..	..	..	..	1	1			
									elg	..	..	1	2							
									cro	8										
									alt	2	..	5	5							
»	»	11[05] pm	»	»	»	Y 200	300	30	Ris	1	2									
									gl	114	92	1	2	3	1					
									Ben				1	3						
									(Hyg)	(2)	(1)	..								
									pun	1	1	1	1							
									Hum	..	..	..	1							
									Dof	13	13	4	1							
									Gem	2	..	1								
									Hol	..	..	..	4	2						
									elg	9	28	4	2							
									cro	..	..	..	..	..	..	1				
									alt	13	1	3	2	..	..	..	1			

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	< 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	> 50
50	17/2 09	1[20] am	37°02′	1°17′	>2000	Y 200	25	30	gl	1	6	7	..	4	6	..	1			
									pun	..	..	..	2	1						
									Hum	..	..	..	..	..	1					
									Dof	5	..	15	17	10	5					
									Hol	..	..	..	2	2						
									mad	..	..	..	..	1	4	2	1			
									cro	3										
									alt	2	..	3								
»	»	2[00] am	»	»	»	Y 200	65	30	gl	24	15	12	6	4	3	1	5			
									(Ben)	..	(3)									
									(Hyg)											
									pun	1	..	..	3	4	2	..	1			
									Hum	..	..	1								
									Dof	1	1	13	3	8	14	2				
									Hol	..	..	..	22	8	1					
									mad	..	..	..	..	..	..	..	..	1		
									elg	5	2									
									cro	..	..	..	..	..	1					
									alt	..	..	4	5	10	5	1	4			
* »	»	2[40] am	»	»	»	Y 200	300	30	gl	..	4	2	2	6	5	2	2			
									pun	..	..	..	3							
									Dof	..	..	8	3	..	..	1				
									Hol	..	..	..	1	1						
									elg	..	2	1								
									cro	..	..	..	..	..	..	..	..	..	1	
									alt	..	..	..	1	1						
* »	»	3[35] am	»	»	»	Y 200	300	30												
»	»	4[10] am	»	»	»	Y 200	600	30	Ris	..	3									
									gl	1	13									
									(Ben)	..	(1)									
									(Hyg)											
									pun	..	..	2								
									Dof	1										
									elg	..	..	1								
									alt	2										
»	»	5[30] am	»	»	»	Y 200	1600	60	Ris	..	2									
									gl	..	..	1	2	2	1	..	1			
									Ben	..	..	..	1	1	2					
									pun	..	1									
									Dof	..	..	..	2	2	1	2				
									Hol	..	..	..	..	1						
									mad	..	..	..	..	..	..	1				
									elg	..	2									
									cro	..	..	..	..	..	..	..	1			
»	»	?	»	»	»	?	?	?	gl	..	..	..	..	1	1					
									Dof	..	..	2	1	1	2	1				
									Hol	..	..	..	1	1						
									alt	..	..	..	..	..	..	1				
			N	W																
51	18/2 09	0[50] am	36°27′	0°37′	>2000	Y 200	300	30	Ris	..	1	2								
									gl	1	25	2								
									pun	1	1	1	1							
									Dof	1										
									elg	..	2	1								
52	18/2 09	7[25] am	35°55′	1°02′	>2000	Y 200	300	30	gl	120	123									
									(Ben)	..	..	(1)								
									(Hyg)											
									pun	6	14	6	3							
									Dof	6	4									
									elg	1	3	2								
									cro	3										
									alt	6										

St. No	Date	Hour	Position Lat. N	Position Long. W	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	∧ 50
53	18/2 09	5.15 µm	36°13′	1°28′	>2000	C 200	2600	90	gl	..	..	..	1	1	1					
									Ben	..	..	..	..	..	3					
									Dof	..	..	..	..	..	2	1				
									alt	..	..	..	..	..	..	..	1			
55	19/2 09	6.30 am	36°46′	2°18′	75	Y 200	25	60	gl	75	55									
									(Ben)	(1)	(4)									
									(Hyg)											
									pun	..	8	3								
									Dof	9	5									
									elg	8	5									
									cro	17	5									
									alt	1										
»	»	7.40 am	»	»	»	Y 200	65	60	gl	28	11									
									(Ben)	..	(1)									
									(Hyg)											
									pun	1	11	2								
									Dof	1	2									
									elg	..	9	4								
									alt	1										
57	20/2 09	5.45 am	36°40′	3°30′	105	Y 200	25	30	gl	336	324	..	..	..	2	13	7			
									Ben			..	..	..	..	..	1			
									(Hyg)	..	(6)									
									pun	21	96	12								
									Dof	150	41									
									mad	..	..	..	..	..	..	..	..	..	1	1 (50) + 1 (51) + 1 (52)
									elg	50	18									
									cro	35	4									
									alt	..	..	..	1							
»	»	6.35 am	»	»	»	Y 200	200	30	Ris	..	6									
									gl	137	117									
									(Ben)											
									(Hyg)	..	(1)	(1)								
									pun	6	17	1								
									Hum	..	1									
									Dof	18	4									
									elg	10	6	5	1							
									cro	5										
									alt	1	1									
58	20/2 09	2.00 pm	36°36′	4°24′	85	Y 200	100	30	gl	43	85	2								
									(Ben)											
									(Hyg)	..	(1)									
									pun	5	51	6	1							
									Dof	..	4									
									Gem	..	2									
									elg	..	..	3	2							
									alt	..	1									
»	»	3.00 pm	»	»	»	Y 200	65	30	gl	17	44	2								
									pun	2	32	17								
									Dof	8	4	1								
									elg	5	1	2								
									cro	7										
									alt	4										
59	21/2 09	0.10 am	36°02′	4°24′	1260	Y 200	25	30	gl	..	..	3	7	6	24	32	40	2		
									Hyg	..	..	..	1							
»	»	1.00 am	»	»	»	Y 200	100	30	gl	10	18	3	3	5	5	14	8	1		
									pun	..	4	1								
									elg	..	3									
»	»	1.40 am	»	»	»	Y 200	500	30	gl	2	7	..	2	3	5	7	4	2		
									pun	..	..	..	1							
									Dof	..	..	..	..	..	1	1				
									Hol	..	..	..	..	..	..	..	1			

St. No	Date	Hour	Position Lat. N	Position Long. W	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 \/	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 /\
59	21/2 09	2[40] am	36°02′	4°24′	1260	Y 200	1200	60	gl	..	2	10	1	2	5	3	6	3		
									pun	..	..	..	1	1						
									Dof	..	..	..	..	..	..	1				
									elg	..	..	..	..	..	1	..	..	..	..	1(62)
»	»	?	»	»	»	?	?	?	pun	..	..	..	2	..	1					
									Dof	..	..	..	2	2	4					
									Hol	..	..	..	1							
									mad	..	..	..	..	..	..	..	1	1		
									elg	..	..	..	..	5	..					
									cro	..	..	..	..	..	1					
61	21/2 09	3[25] pm	35°57′	5°35′	740	Y 200	600	60	gl	..	..	7	1	1	1					
									Ben	..	..	1								
									pun	..	..	..	..	1						
»	»	?	»	»	»	?	?	?	Dof	..	..	..	..	..	..	1				

Summer cruise. Mediterranean (Western Basin).

St. No	Date	Hour	Position Lat. N	Position Long. W	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 \/	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 /\
98	23/6 10	6[35] pm	35°57′	5°35′	700	Y 200	65	15												
99	23/6 10	11[25] pm	36°02′	5°16′	750	Y 200	300	30	gl	81	93	22	7	4	6	15	20	6	4	18(50) +
									(Ben)	(3)	(34)	(1)								4(51) +
									(Hyg)											2(52) +
									pun	5	76	18	2	..	..	1				1(54) +
									Dof	3	1	1	..	..	2	36	4				1(56)
									mad	..	..	..	..	..	..	..	..	65	111	
									elg	10	9									
»	24/6 10	0[10] am	»	»	»	Y 200	65	15	gl	..	..	2	12	7	2	7	6	2		
									pun	..	1	..	..	..	..	..	1	..	1	1(51)
									cro	6	6									
104	24/6 10	6[20] pm	36°37′	2°04′	250	Y 200	65	30	gl	16	40	1								
									(Ben)	(17)	(143)	(10)								
									(Hyg)											
									pun	..	19	84	21							
									Dof	10	38	9								
									Hol	..	..	1								
									mad	6	7	34	2							
									elg	3	7	5								
									cro	9	15	11	2							
105	24/6 10	7[45] pm	36°43′	2°08′	20	Y 200	40	15	(Ben)	(1)	(8)									
									(Hyg)											
									Hol	..	1									
									mad	..	..	1								
106	25/6 10	0[20] am	36°33′	2°00′	ca1100	Y 200	1200	60	Ris	..	..	..	..	..	..	1				
									gl	..	..	39	11	5	1	2				
									(Ben)	(1)	(3)	(1)								
									(Hyg)											
									pun	..	8	4	1	4						
									Dof	..	7	5								
									Hol	..	1									
									mad	2	5	3	3							
									elg	..	..	1	..	1						
									cro	2	2	1	1	2	..	..	..	..	..	1(69)
									alt	1	..	..	2	1	1	1				
»	»	1[45] am	»	»	»	Y 200	300	30	gl	6	33	34	30	8	1	1				
									Ben	(3)	(16)	(10)	..	..	..	..	..	..	1	
									(Hyg)											
									pun	2	26	29	9	3	1					
									Dof	2	6	6	..	1	13	22	1			
									mad	7	8	12	..	..	..	..	..	..	..	1
									elg	..	5	10	1							
									cro	3	4	5	..	2						
									alt	..	2	..	1							

St. No	Date	Hour	Position Lat. N	Position Long. W	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40 45	45—50	∧ 50
106	25/6 10	2³⁰ am	36°33′	2°00′	ca1100	Y 200	65	30	Ben	(3)	(6)	..	..	..	..	..	..	1		
									(Hyg) pun	..	..	5	..	1	..	..	..	2		
									Dof	3	21									
									Hol	..	3									
									mad	28	4									
									cro	25	29	16								
107	25/6 10	7³⁰ am	36°18′	1°14′	ca2250	Y 200	2000	60	gl	..	..	28	9	3	..	1				
									Ben			2								
									(Hyg)	..	..	(7)								
									pun	..	..	5	8	..	1					
									Dof	..	..	1	..	3	2	3				
									mad	1	..	1								
									elg	2	..	1	2							
									cro	..	1	1	2	2	1					
									alt	..	..	..	1	..	..	..	1			
»	»	0⁰⁵ am	»	»	»	Y 200	300	30	Ris	..	1									
									gl	8	7	1								
									(Ben)											
									(Hyg)	(3)	(6)	(6)								
									pun	2	5	21	10							
									Dof	2	5	1								
									elg	..	1	1	2							
									cro	..	5	2								
									alt	1										
»	»	9⁵⁰ am	»	»	»	Y 200	65	30	gl	57	52	3								
									(Ben)											
									(Hyg)	(34)	(80)	(5)								
									pun	..	18	30	3							
									Dof	41	42									
									mad	4										
									elg	6	13									
									cro	16	34	14								
									alt	13	2									
108	25/6 10	10³⁰ pm	36°03′	0°27′	>2400	Y 200	300	30	gl	480	478	29	49	27	3	4	5			
									(Ben)											
									(Hyg)	(30)	(90)									
									pun	29	110	85	21							
									Hum	..	2									
									Dof	5	22	7	6	5	5	9	3			
									mad	89	108	27								
									elg	9	11	20	3	..	..	..	..	..	1	
									cro	..	..	..	..	2	5	..	..	..	..	1(55)
									alt	3	..	..	10	2	2	6	4			
»	»	11¹⁵ pm	»	»	»	Y 200	65	30	gl	20	15	12	1							
									Ben											
									(Hyg)	(41)	(25)	..	..	..	..	..	..	1		
									pun	4	3	12	5	2	1					
									Dof	13	29	2	2	..	..	1				
									mad	107	8	1	1							
									elg	..	3	2								
»	»	11⁵⁵ pm	»	»	»	Y 200	25	15	Ben	..	..	1	1							
									pun	..	..	..	..	3	3	3				
									Hol	..	1									
									mad	6	1									
									cro	10	24	8								
									alt	..	1									
»	26/6 10	0⁴⁰ am	»	»	»	Y 200	2000	60	gl	18	77	28	4	2						
									(Ben)											
									(Hyg)	(18)	(25)	(6)								
									pun	..	9	10	13	1	2					
									Dof	2	2	5	..	..	2	4				
									Hol	..	..	..	..	..	..	..	1			
									mad	6	15	3	1							
									elg	2	1	3	1							
									cro	4	6	5	1	..	1					
									alt	1	..	2								

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	< 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	> 50
112	27/6 10	0¹⁵ am	36°56′	2°15′	2700	Y 200	300	30	gl	28	52	2	1							
									(Ben)	(12)	(53)	(12)								
									(Hyg)											
									pun	..	14	17	5	1						
									Dof	2	1	1	..	..	..	2	2			
									Hol	..	1	..	..	..	..	2	2			
									mad	8	17	6	..	..	..	..	..	1		
									elg	1	3	5	..	1						
									cro	4	2	..	..	2	1					
									alt	2	2	..	1	1	..	4	2			
»	»	1⁰⁵ am	»	»	»	Y 200	65	15	gl	2	..	1								
									(Ben)	(8)	(3)									
									(Hyg)											
									pun	..	..	..	..	1						
									Dof	..	..	..	2							
									Hol	..	1									
									mad	35	14	..	..	..	..	..	..	..	1	
									cro	16	15	1								
»	»	1³⁰ am	»	»	»	Y 200	25	15	Ben											
									(Hyg)	..	(1)	..	1							
									pun	..	..	..	..	..	1	..	..	..	1	
									mad	30	2									
									cro	7										
113	28/6 10	3²⁵ am	36°53′	3°09′	815	Y 200	300	30	Ris	1										
									gl	2	7	7								
									(Ben)	(9)	(19)	(10)								
									(Hyg)											
									pun	1	5	2	7	4	2					
									Dof	4	12	3	2	..	4	5	5			
									Hol	..		..	..	..	..	4	5	1		
									mad	2	7	3								
									elg	..	2	5	5							
									cro	6	9	12								
									alt	7										
115	28/6 10	11²⁰ pm	38°17′	4°11′	2800	Y 200	300	30	Ris	1										
									gl	..	3	1	5	1	1					
									Ben	..	(45)	(22)	2	..	..	..	..	..	1	
									Hyg				..	..	..	..	..	..		
									pun	..	1	7								
									Hum	..	..	4								
									Dof	..	1									
									Hol	..	1	..	..	..	..	3				
									Raf	..	..	..	..	..	..	1				
									mad	1	..	3								
									elg	..	7	1	..	1						
									alt	..	1	..	3	..	..	2	2	1		
»	29/6 10	0³⁰ am	»	»	»	Y 200	2000	60	Ris	..	..	1								
									gl	..	1	1	5							
									Ben	(6)	(6)	12	1							
									(Hyg)			(10)								
									pun	1	..	..	..	..	3					
									Hum	..	2									
									Dof	..	1	2	..	1	2					
									Hol	..	..	..	..	..	1					
									Raf	..	..	..	..	..	..	..	..	1		
									mad	3	12	6	1							
									cro	..	1	..	..	1						
									alt	2	..	1	1	2						
»	»	1³⁰ am	»	»	»	Y 200	65	15	Ben	..	..	..	..	1						
									pun	..	..	..	..	1						
									Hol	2	1									
									mad	39	4									
									cro	4										

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	V 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	∧ 50
115	29/6 10	1^{40} am	38°17′	4°11′	2800	Y 200	25	15	Ben	..	(1)	..	2							
									(Hyg)	..	..	..	1							
									pun	9	2									
									mad	1										
									cro											
116	29/6 10	4^{05} pm	39°27′	5°26′	2860	Y 200	300	30	gl	..	1									
									(Ben)	..	(1)									
									(Hyg)	..	1									
									Hum	..	1									
									cro											
»	30/6 10	1^{40} am	»	»	»	Y 200	300	30	gl	..	..	1	1	1						
									Hyg	..	..	..	..	1	..	..	1			
									pun	..	..	..	..	4	2	1				
									Dof	..	..	..	1	1	..	..	..	1		
									Raf	..	..	..	..	..	..	..	1			
									mad	..	1	1	1							
									elg	..	..	..	..	..	..	1				
									cro	..	..	..	..	1	1					
									alt	..	..	..	..	1	..	..	4	1		
»	»	2^{30} am	»	»	»	Y 200	65	30	gl	..	..	..	1							
									(Ben)	(6)	(8)									
									(Hyg)											
									pun	..	..	..	..	1						
									Dof	..	..	..	6	2						
									mad	4	15	1								
									cro	..	1									
»	»	3^{00} am	»	»	»	Y 200	25	15	Ben	..	(1)	..	1	1						
									(Hyg)											
									mad	26	14									
									cro	3	1	1								
118	30/6 10	5^{55} pm	41°00′	6°43′	>2700	Y 200	300	30	(Ben)	..	(5)									
									(Hyg)											
									Hum	2	2	..	..	..	1*	1*				
»	»	10^{55} pm	»	»	»	Y 200	300	30	Ris	1										
									(Ben)	(4)	(4)									
									(Hyg)											
									pun	..	1									
									Hum	..	2	1								
									mad	..	3	6	1	..	..	..	..	..	1	
									cro	..	..	..	..	..	..	1				
									alt	..	..	..	1	..	..	1	2			
»	»	11^{35} pm	»	»	»	Y 200	65	30	gl	..	..	1								
									(Ben)	(31)	(11)									
									(Hyg)											
									Hum	..	4	..	..	..	5					
									Dof	..	..	1	..	1						
									Raf	..	..	..	..	..	1						
									mad	..	3	1	..	..	..	..	..	..	..	1 (55)
									elg	..	..	..	..	..	..	1				
									cro	..	..	..	..	..	3	1				
									alt	..	..	..	1							
»	1/7 10	0^{30} am	»	»	»	Y 200	25	15	gl	..	..	..	2							
									(Ben)	(21)	(61)	(1)								
									(Hyg)											
									Hum	..	..	..	..	..	..	2				
									Dof	..	..	..	2							
									mad	12	63	65	2							
									cro	2	3									
									alt	..	..	..	1							
120	1/7 10	8^{50} pm	42°31′	7°41′	>2700	Y 200	300	30	gl	..	..	..	1	1	..	1				

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
121	2/7 10	3⁰⁵ am	43°08′	8°05′	>2500	Y 200	25	30	(Ben)	..	(1)									
									(Hyg)	..	2									
									mad	3	1									
122	2/7 10	10⁰⁰ am	43°50′	8°34′	1285	Y 200	600	60	Hum	..	3									
									Hol	..	1									
									mad	10	39	8								
									cro	5	1									
»	»	5³⁰ am	»	»	»	Y 200	1200	30	gl	..	..	..	1	..	1					
									Ben	..	..	1								
									pun	..	..	..	1	1						
									mad	..	..	..	2	2						
									cro	..	1	1								
123	3/7 10	0⁰⁵ am	44°14′	8°55′	ca 700	Y 200	300	30	pun	..	3									
									mad	..	..	1								
									cro	1	2									
»	»	0⁵⁵ am	»	»	»	Y 200	65	30	gl	..	..	..	..	..	..	..	..	1		
									(Ben)	(1)	(16)	(1)								
									(Hyg)											
									pun	..	..	..	..	1	..	1	..	1		
									Hum	4	28	14	..	..	1					
									Dof	3	2									
									mad	1	3	6	..	..	..	..	..	..	..	1(70)
									cro	20	51	12								
»	»	1⁵⁰ am	»	»	»	Y 200	25	15	gl	..	..	..	..	2						
									mad	2	1									
»	»	2³⁰ am	»	»	»	Y 200	10	15	mad	36	2									
124	3/7 10	3³⁰ am	44°20′	9°05′	86	Y 200	65	90												
125	9/7 10	9⁴⁵ pm	43°54′	9°13′	1082	Y 200	300	30	gl	..	..	..	1	1						
									(Ben)	..	(1)									
									(Hyg)											
									mad	..	1	1								
									cro	..	1									
»	»	10³⁰ pm	»	»	»	Y 200	25	30	gl	..	..	..	1							
									(Ben)	..	(3)	(3)								
									(Hyg)											
									mad	..	..	8								
									elg	..	..	..	..	..	..	..	2	1	..	1(57)
									cro	7	13	2								
									alt	..	..	..	..	1	1					
126	10/7 10	9³⁰ pm	42°43′	9°50′	588	Y 200	300	30	gl	..	..	1	1	..	..	..	..	..	1	
									(Ben)	..	(1)									
									(Hyg)											
									pun	..	..	..	1							
									mad	..	1	1								
»	»	10¹⁰ pm	»	»	»	Y 200	25	30	mad	16	32	11	..	1						
129	12/7 10	3⁰⁰ am	40°05′	11°31′	3420	Y 200	25	30	(Ben)	..	(2)									
									(Hyg)											
									Hum	..	1									
									Dof	..	..	..	1							
									Hol	2										
									mad	50	55	5	..	3						
									cro	8	3									
»	»	3⁴⁰ am	»	»	»	Y 200	300	30	Ris	..	3									
									pun	..	..	1								
									Hum	..	3	1								
									mad	2	3	..	..	1						
									alt	3	1									

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	< 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	> 50
129	12/7 10	4²⁰ am	40°05′	11°31′	3420	Y 200	1000	60	gl	..	..	..	..	..	1					
									Hyg	..	..	..	..	1						
									pun	..	..	..	..	3						
									Hum	..	1	..	..	..	1					
									mad	..	1	..	..	2	1					
									cro	1										
									alt	..	..	..	..	..	..	1				
»	»	3⁰⁰ pm	»	»	»	C 200	3500	120	Ben	..	..	5								
									mad	..	..	..	..	..	..	1				
»	»	8⁰⁰ pm	»	»	»	Y 200	600	30	gl	..	..	..	..	1						
									(Ben) (Hyg)	..	(1)									
									pun	..	..	..	..	..	1					
									Hum	..	..	1								
									mad	..	..	4	..	1						
									cro	1	..	..	..	..	1					
									alt	..	..	..	..	..	1					
130	13/7 10	0⁵⁰ am	39°35′	11°20′	>3000	Y 200	25	30	gl	..	..	..	1							
									(Ben) (Hyg)	(12)	(20)	(2)								
									Hum	..	..	..	..	..	1					
									Dof	..	..	1	2							
									Hol	..	2									
									mad	31	26	29	..	11						
									cro	4	1									
									alt	1	..	..	1							
131	13/7 10	9⁵⁰ am	38°36′	11°00′	915	Y 200	25	30	mad	5	1									
»	»	10³⁵ am	»	»	»	Y 200	300	30												
»	»	10⁴⁰ am	»	»	»	Y 200	1000	60	Ris	..	1									
									gl	1	1	..	3	1						
									(Ben) (Hyg)	(1)	(3)									
									pun	3	1	2	1							
									Hum	..	1	1								
									Dof	..	5	5	3	1						
									elg	..	1									
									cro	2										
									alt	2	1									
132	14/7 10	0⁵⁵ am	38°57′	9°47′	1227	Y 200	1500	60												
»	»	3⁰⁵ am	»	»	»	Y 200	25	30	(Ben) (Hyg)	(26)	(25)									
									pun	..	..	..	..	2						
									Hum	..	2	1	..	..	..	1				
									Dof	..	..	1								
									mad	40	8	2	1	4						
									elg	1										
									cro	16	1									
									alt	6										
»	»	3⁴⁵ am	»	»	»	Y 200	300	30	gl	..	..	..	2							
									(Ben) (Hyg)	(5)	(2)	(3)								
									pun	3	4	3								
									Hum	..	2									
									Dof	..	..	2	1	..	1					
									Raf	..	..	..	..	..	..	..	1			
									mad	3	1									
									alt	2										

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	V 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
132	14/7 10	4^{50} am	38°57′	9°47′	1227	Y 200	600	30	(Ben)	(3)	(2)									
									(Hyg)											
									pun	..	2	1								
									Hum	..	2	1								
									Dof	..	1									
									mad	3										
									alt	1										
133	14/7 10	9^{20} pm	38°18′	9°59′	602	Y 200	600	30	(Ben)	(3)	(10)	(2)								
									(Hyg)											
									pun	..	..	1	..	1						
									Hum	..	..	1								
									Dof	..	1	1	..	..	..	..	1			
									Raf	..	..	..	..	..	..	1				
									mad	3	3	2								
									elg	..	..	..	..	..	..	..	..	1		
									cro	1										
»	»	10^{15} pm	»	»	602	Y 200	300	30	gl	..	3									
									(Ben)	(4)	(14)	(15)	..	..	..	..	1			
									Hyg											
									pun	..	..	3								
									Dof	..	..	..	..	..	2	..	1			
									Hol	..	1									
									mad	..	..	20	3							
									elg	..	2									
									cro	2	1	1								
»	»	11^{00} pm	»	»	»	Y 200	25	30	(Ben)	(4)										
									(Hyg)											
									Hol	1	3									
									mad	5	11	4								
									cro	1										
134	15/7 10	4^{50} am	37°37′	10°17′	350	Y 200	25	30	(Ben)	(26)	(47)	(1)								
									(Hyg)											
									Dof	1										
									Hol	..	1									
									mad	16	29	8	1							
									cro	2	1									
									alt	1										
»	»	5^{40} am	»	»	400	Y 200	300	30	Ris	1										
									(Ben)	(3)	(3)									
									(Hyg)											
									pun	..	2									
									Hum	..	1	1								
									Dof	..	1									
									mad	1	1									
									elg	..	1									
									alt	2										
135	16/7 10	0^{55} am	37°17′	10°28′	200	Y 200	25	30	gl	1										
									(Ben)	..	(1)									
									(Hyg)											
									mad	..	6	2	1							
136	19/7 10	3^{10} am	37°01′	10°31′	80	Y 200	25	30												
»	»	3^{50} am	»	»	»	Y 200	100	30	mad	1										
137	19/7 10	8^{15} am	37°17′	10°56′	190	Y 200	25	30	mad	16	2	1								
									cro	1										
»	»	9^{05} am	»	»	195	Y 200	250	30	mad	..	1									
138	19/7 10	7^{40} pm	37°37′	11°25′	788	Y 200	1000	60	(Ben)	(4)	(7)	(14)								
									(Hyg)											
									pun	..	2	1	..	..	..	..	..	1		
									Dof	..	..	..	..	..	1					
									mad	2	1	2								
									cro	2										

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	∧ 50
138	19/7 10	9[10] pm	37°37′	11°25′	788	Y 200	300	60	(Ben)	(13)	(79)	(109)								
									(Hyg)											
									pun	..	5									
									Hum	1										
									Dof	..	5	..	..	..	1	2				
									mad	..	11	16	1							
									cro	8	3									
									alt	1	2									
»	»	9[50] pm	»	»	»	Y 200	25	30	(Ben)											
									(Hyg)	(1)										
									Hol	2	3									
									mad	24										
									cro	1										
139	20/7 10	1[40] am	37°57′	11°54′	680	Y 200	25	30	Dof	..	..	..	1							
									mad	6	12	7								
»	»	2[25] am	»	»	530	Y 200	300	30	(Ben)											
									Hyg	..	(1)	..	..	..	..	..	..	..	1	
									Dof	..	..	..	..	..	3					
»	»	3[40] am	»	»	580	Y 200	800	60	Dof	..	..	..	..	1	2					
									mad	..	1									

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141	20/7 10	10[35] pm	36°42′	13°34′	530	Y 200	25	15	Hol	..	1									
142	22/7 10	2[50] am	35°44′	15°07′	98	Y 200	25	30	mad	67	19	3								
»	»	3[40] am	»	»	»	Y 200	150	30	(Ben)											
									(Hyg)	(1)	(2)									
									Dof	2	1									
									mad	3	1									
									cro	5	1	1								
143	23/7 10	0[30] am	35°18′	16°25′	1842	Y 200	300	30	Ris	3	4									
									Ben			(3) 2	1							
									Hyg	(5)	(10)		1							
									pun	1	12	1	1	1						
									Hum	..	2	..	1	..	1					
									Coc	2										
									Dof	1	1	4	..	..	1	..	1			
									Hol	..	2	1								
									mad	..	6	7	1	1						
									alt	6	2	..	2	1	..	..	..	1		
»	»	1[20] am	»	»	»	Y 200	25	30	Ben	..	..	7	7							
									Hol	1	4	..								
									mad	3	4	2								
»	»	2[00] am	»	»	»	Y 200	1000	60	(Ben)											
									(Hyg)	(7)	(4)	(3)								
									pun	..	1									
									Dof	..	1	2	..	..	1					
									Hol	..	..	1								
									mad	1	5	1	1	1						
									cro	..	2									
									alt	2										
*144	24/7 10	2[00] am	34°31′	18°40′	3340	Y 200	25	30	Hol	1	1									
									mad	14	57	19								
»	»	2[45] am	»	»	»	Y 200	300	30	(Ben)											
									(Hyg)	(1)	(1)									
									Coc	..	2									
									Gem	..	..	..	..	1						
									mad	..	5	8	1	3						
									alt	..	..	..	..	2	..	2	1			

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
144	24/7 10	3^{45} am	34°31′	18°40′	3340	Y 200	2000	60	mad	..	..	..	1	1						
»	»	6^{20} am	»	»	»	C 200	4000	60	mad	..	..	..	1							
									alt	..	..	..	..	..	..	..	1			
* »	»	9^{00} am	»	»	»	Y 200	25	30												
145	25/7 10	3^{30} am	32°38′	19°02′	»	Y 200	25	30	Coc	..	..	3								
									mad	18	4	1								
»	»	4^{10} am	»	»	1925	Y 200	300	300	Ris	..	2									
									(Ben)											
									(Hyg)	(1)										
									pun	1	3									
									Coc	2										
									mad	..	1	1	2							
147	25/. 10	11^{35} pm	31°35′	19°02′	993	Y 200	25	30	(Ben)											
									(Hyg)	..	(1)									
									Coc	..	1									
									mad	7										
»	26/7 10	0^{20} am	»	»	»	Y 200	300	20	(Ben)											
									(Hyg)	(7)	(1)									
									pun	4	1	1								
									Coc	2	3									
									mad	5	..	..	1	4						
									alt	3										
»	»	1^{10} am	»	»	993	Y 200	1000	60												
152	27/7 10	10^{50} pm	33°11′	21°44′	>2200	Y 200	25	15												
»	»	11^{35} pm	»	»	»	Y 200	300	30	(Ben)											
									(Hyg)	..	..	(2)								
									pun	..	4									
									Coc	..	1									
									Hol	..	1									
									mad	..	1	1								
»	28/7 10	0^{30} am	»	»	»	Y 200	1000	60	mad	..	..	..	..	1						
									alt	1										
154	29/7 10	3^{30} am	32°10′	24°46′	365	Y 200	25	30												
»	»	4^{30} am	»	»	»	Y 200	300	30	(Ben)											
									(Hyg)	..	(1)									
									pun	..	3	..	2							
									alt	2										
156	30/7 10	0^{40} am	32°16′	26°03′	ca3200	Y 200	1000	60	(Ben)											
									(Hyg)	(2)										
									Coc	..	2									
									mad	1	1									
									alt	2	..	..	..	..	..	..	1			
»	»	2^{15} am	»	»	»	Y 200	25	30	Ben	..	..	..	..	1						
»	»	3^{00} am	»	»	»	Y 200	600	30	(Ben)											
									(Hyg)	(1)										
									pun	..	1									
									Coc	..	1									
									mad	..	..	..	..	2						
									alt	..	..	..	..	..	1					
»	»	3^{50} am	»	»	»	Y 200	300	30	(Ben)											
									(Hyg)	(1)										
									Dof	..	..	1								
									Raf	..	..	..	..	..	1					
									mad	..	..	1								

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	< 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	> 50
158	31/7 10	7³⁰ am	34°23′	27°57′	>2000	Y 200	300	30	(Ben) (Hyg)	(14)	(14)									
									Hum	..	3									
									Coc	..	1	1								
									Hol	..	..	1								
									Raf	..	..	..	..	..	1					
									mad	..	..	..	..	1						
									alt	..	..	..	..	..	1					
*160	1/8 10	2⁰⁰ am	35°59′	28°14′	>1000	Y 200	25	30	mad	36										
»	»	2⁴⁵ am	»	»	»	Y 200	300	30	Ris	..	3	..	..	1						
									(Ben) (Hyg)	(5)	(3)									
									Hum	..	1									
									Coc	2										
									Hol	1										
									mad	..	..	2	1							
									alt	1	..	..	..	..	..	..	1			
»	»	3³⁵ am	»	»	»	Y 200	1000	60	Ris	1										
									(Ben) Hyg	(1)	..	(1)	..	..	..	..	1			
									Hum	..	1									
									Coc	..	1	..	1							
									Dof	..	..	..	..	1	1					
									Hol	1	1	1								
									mad	1	1	..	..	1						
									alt	1	..	..	..	..	..	..	1			
* »	»	2²⁰ pm	»	»	2980	Y 200	25	30												
»	»	3³⁰ pm	»	»	»	C 200	4000	60	Ben (Hyg)	..	..	(1) 2	1							
									Coc	..	1									
161	2/8 10	3⁰⁰ am	36°12′	27°16′	>1000	Y 200	25	30	(Ben) (Hyg)	(1)										
									mad	41	17	..	..	1						
163	3/8 10	0⁰⁵ am	37°52′	26°22′	1170	Y 200	1000	30	(Ben) (Hyg)	(3)	(1)									
									Hol	..	1									
									mad	1	6	16	1							
»	»	1⁰⁵ am	»	»	1170	Y 200	300	15	(Ben) (Hyg)	(2)	(3)	(2)								
									Coc	..	1									
									Dof	..	..	1	..	..	1					
									Hol	..	1	1								
									mad	2	14	32	2	4						
»	»	1⁴⁰ am	»	»	»	Y 200	25	15	Dof	..	..	1								
									Hol	..	1									
									mad	44	125	45	..	5						

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171	10/8 10	3²⁵ pm	41°07′	29°05′	60	Y 200	50	15	gl	1										
									(Ben) (Hyg)	(5)	(1)									
172	11/8 10	2¹⁰ am	41°32′	29°24′	1090	Y 200	600	20												
»	»	2⁵⁰ am	»	»	»	Y 200	100	15												
»	»	3²⁵ am	»	»	»	Y 200	50	15												

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
172	11/8 10	3⁵⁰ am	41°32′	29°24′	1090	Y 200	10	15												
173	11/8 10	6³⁰ am	41°17′	29°11′	65	Y 200	65	15												
174	11/8 10	11⁵⁰ am	40°54′	28°53′	120	Y 200	65	30	gl	1	2									
									(Ben)	26)	(9)									
									(Hyg)											
									cro	3										
175	11/8 10	9⁴⁵ pm	40°48′	27°59′	1103	Y 200	10	15												
»	»	10¹⁵ pm	»	»	»	Y 200	35	15	gl	..	..	5	5	..	..	4				
									(Ben)	(1)										
									(Hyg)											
»	»	10⁴⁵ pm	»	»	»	Y 200	100	15	gl	9	1	2	..	3	9	23	11			
									(Ben)	(143)	(56)									
									(Hyg)											
									cro	5										
»	»	11²⁰ pm	»	»	»	Y 200	400	30	gl	..	1	2	1	..	3	8	7			
									(Ben)	(21)	(11)	(2)								
									(Hyg)											
»	12/8 10	0²⁵ am	»	»	»	Y 200	1200	30	gl	3	6	11	1	2	5	10	4			
									Ben	(66)	(13)	(1)[3]								
									(Hyg)											
									cro	..	..	..	..	..	..	..	..	..	..	1 (52)
176	12/8 10	4⁰⁰ am	40°45′	27°43′	> 500	Y 200	65	30	gl	..	..	..	..	..	1					
									Ben	(81)	(2)	..	..	..	..	..	..	2		
									(Hyg)											
									cro	1										
178	12/8 10	0²⁰ pm	40°16′	26°32′	ca 70	Y 200	65	15	(Ben)	..	(1)									
									(Hyg)											
									cro	..	1									
»	»	0⁴⁰ pm	»	»	»	Y 200	10	15												

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179	13/8 10	2¹⁵ am	40°02′	25°55′	85	Y 200	65	30	(Ben)	(8)	(29)	(2)								
									(Hyg)											
									mad	4	18	9	1							
181	13/8 10	1²⁵ pm	38°49′	25°09′	255	Y 200	300	20	(Ben)	..	(1)									
									(Hyg)											
									Hol	..	1									
»	»	2⁵⁵ pm	»	»	»	Y 200	65	15	(Ben)	(18)										
									(Hyg)											
									mad	1	6	..	1							
182	14/8 10	10³⁰ pm	38°13′	24°48′	500	Y 200	65	15	(Ben)	(30)	(27)	(2)								
									(Hyg)											
									pun	..	..	..	..	..	..	..	1			
									Hol	..	11									
									mad	70	140	45	2	2						
»	»	11⁰⁰ pm	»	»	»	Y 200	10	15	Hol	..	1									
									mad	13	35	10								
»	»	11⁴⁰ pm	»	»	»	Y 200	600	30	(Ben)	(7)	(14)	(11)								
									(Hyg)											
									pun	..	3									
									Hol	..	1	1								
									mad	3	6	22	5							

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
183	16/8 10	4[45] pm	37°52′	23°09′	233	Y 200	300	15												
»	»	5[10] pm	»	»	»	Y 200	65	15												
184	17/8 10	1[50] am	38°10′	22°33′	842	Y 200	10	15	mad	2	1	4	11	3						
»	»	2[15] am	»	»	»	Y 200	65	15	gl	..	..	3	8	..	..	1	1			
									Ben			1								
									(Hyg)	(32)	(2)									
									mad	2	9	3	10	14						
									cro	5	2									
»	»	2[45] am	»	»	»	Y 200	1000	30	(Ben)											
									(Hyg)	..	(1)									
									Coc	..	1									
									Hol	..	..	1								
									mad	..	..	1	1	2						
185	17/8 10	11[05] am	38°12′	21°17′	>50	Y 200	25	15												
186	17/8 10	8[15] pm	37°57′	19°51′	>3000	Y 200	300	15	gl	..	..	..	..	1						
									Ben	..	..	1								
									Hum	..	1									
									Coc	..	1	1								
									Hol	..	1									
									mad	3	6	1	1	5						
									alt	3	1	..	..	..	1					
»	»	11[30] pm	»	»	»	Y 200	10	15	Ben	..	..	..	1							
									mad	2	27	10								
»	»	12[00] pm	»	»	»	Y 200	65	15	Ben	..	..	1								
									Hum	..	..	1								
									mad	1	7	2								
»	18/8 10	0[45] am	»	»	»	Y 200	1200	30	Ris	..	..	1								
									Coc	..	1	1								
									mad	2	4	2	..	2						
187	18/8 10	0[55] pm	37°54′	18°02′	>2500	Y 200	300	15	Ris	..	1									
									(Ben)											
									(Hyg)	..	(1)									
									Hum	..	..	1								
									Coc	1	1									
»	»	6[40] pm	»	»	»	Y 200	1000	30	Ben			3								
									Hyg	..	(1)	..	1							
									Coc	..	1									
									mad	..	..	..	1							
									alt	2	..	..	..	..	..	..	..	1		
»	»	7[45] pm	»	»	»	Y 200	25	15	mad	7	1	2								
189	19/8 10	8[55] am	37°44′	15°58′	>2000	Y 200	300	15	Ris	..	1									
									(Ben)											
									(Hyg)	..	(1)									
									Coc	1	1	1								
									Dof	..	1									
									Hol	..	1									
									alt	1										
»	»	9[30] am	»	»	»	Y 200	1000	30												
»	»	2[40] am	»	»	»	Y 200	25	15												
190	19/8 10	8[15] pm	37°51′	15°19′	360	Y 200	25	15												
192	20/8 10	9[40] pm	38°07′	15°35′	652	Y 200	25	15	Ben											
									(Hyg)	..	(1)	1	2							
									mad	..	1									

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
192	$^{20}/_{8}$ 10	10^{10} pm	38°07′	15°35′	652	Y 200	300	15	Ben	..	..	(1) 1	1							
									(Hyg)	..	..									
									mad	..	..	1								
»	»	10^{50} m	»	»	»	Y 200	600	30	gl	..	..	..	..	1	1					
									Ben	..	..	(1) 9	4							
									Hyg	..	..		1							
									pun	..	..	1								
									alt	1										

Mediterranean (Western Basin).

193	$^{21}/_{8}$ 10	0^{50} am	38°15′	15°39′	>100	Y 200	10	30	(Ben)	(1)	(1)									
									(Hyg)											
									Hol	..	4									
									mad	6	7									
194	$^{21}/_{8}$ 10	4^{30} am	38°33′	15°29′	1140	Y 200	10	15	mad	1	1	..	2	1						
»	»	5^{00} am	»	»	»	Y 200	25	15	Hol	..	2									
									mad	1	..	2								
»	»	6^{00} am	»	»	»	Y 200	1200	30	gl	..	..	..	..	1						
									Ben	..	..	3	2	3						
									pun	..	..	..	..	1						
									Hol	..	..	1								
									mad	1										
									alt	1										
195	$^{21}/_{8}$ 10	6^{10} pm	39°02′	14°55′	ca3160	Y 200	300	30	Ris	1	1									
									(Ben)											
									(Hyg)	..	(1)									
»	»	6^{50} pm	»	»	»	Y 200	65	15	(Ben)											
									(Hyg)	..	(3)									
									alt	2										
196	$^{22}/_{8}$ 10	2^{40} am	39°59′	14°31′	>600	Y 200	25	30	Ben	..	..	5								
									mad	2	3	4								
197	$^{24}/_{8}$ 10	7^{00} pm	40°34′	13°36′	>1000	Y 200	300	30	(Ben)											
									(Hyg)	..	(5)									
									Hol	..	1									
									mad	1										
»	»	7^{45} pm	»	»	»	Y 200	25	15	(Ben)											
									(Hyg)	(1)	(1)									
									Hum	..	..	..	..	..	..	..	..	..	..	1 (84)
									Dof	..	..	..	2							
									Hol	..	1									
									mad	3	3	1								
199	»	9^{00} pm	39°32′	10°49′	ca2700	Y 200	25	15	pun	..	..	..	..	1	..	..	1			
									Hum	..	..	..	..	..	..	1				
									Hol	..	1									
									mad	6	23	15								
»	»	9^{25} pm	»	»	»	Y 200	300	20	Ris	1	3									
									gl	..	..	1								
									Ben	..	..	..	1							
									pun	..	1	2	1							
									Hum	..	2	1								
									Dof	..	1	1								
									Hol	..	..	2								
									Raf	..	..	..	..	..	..	..	1			
									mad	1	4	3	..	..	1					
									cro	1										
									alt	3	1									

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
199	25/8 10	10¹⁰ pm	39°32′	10°49′	ca2700	Y 200	1000	30	Ben	..	..	..	1							
									Hum	..	1	..	..	..	..	..	..	..	..	1(82)
									Dof	1	3									
									Raf	..	..	..	..	..	..	..	..	1		
									mad	..	2	4								
									alt	3										
200	26/8 10	3⁴⁵ am	39°18′	10°11′	>2000	Y 200	25	30	Ben	..	..	23	11							
									mad	5	1									
202	26/8 10	5⁰⁵ pm	38°59′	9°25′	760	Y 200	300	15	Ris	1										
									(Ben) (Hyg)	(1)	(3)									
									mad	..	..	1								
204	27/8 10	4⁰⁰ am	38°52′	7°43′	>1000	Y 200	25	15	Ben	..	..	16	23	2	1					
									Hol	..	2									
									mad	..	..	1								
»	»	4³⁰ am	»	»	»	Y 200	65	15	Ben (Hyg)	(3)	..	3	4	3	1					
									Hum	..	2									
									mad	11	7	..	2							
									cro	3	1									
»	»	5⁰⁰ am	»	»	»	Y 200	300	30	Hum	..	1									
									Dof	..	..	1								
									mad	..	1	1								
»	»	5⁴⁵ am	»	»	»	Y 200	1000	30	gl	..	..	1	1							
									Ben (Hyg)	..	..	(1)[7]	5	1	..	..	..	..	1	
									Dof	..	..	1								
									mad	..	..	..	3	1						
									alt	..	..	..	3	2						
205	27/8 10	7³⁵ pm	39°16′	5°52′	ca2860	Y 200	25	15	(Ben) (Hyg)	..	(1)									
									Raf	3										
									mad	21	2	3								
206	28/8 10	0³⁰ am	39°32′	5°15′	ca2860	Y 200	25	15	Ben	..	..	1	2	2						
									mad	2	1									
»	»	1⁰⁵ am	»	»	»	Y 200	300	15	Ris	..	4									
									gl	..	..	3	2	3						
									(Ben) (Hyg)	(19)	(100)	(21)								
									Hum	1	3	4								
									Dof	2										
									mad	1	3	..	2							
									cro	1	1	..	..	..	1	1				
									alt	5	4	..	..	..	1	..	1			
»	»	1⁴⁰ am	»	»	»	Y 200	1000	45	Ris	..	1									
									Ben (Hyg)	(15)	(34)	(2)	..	1						
									Hum	..	..	2								
									Dof	..	1									
									Raf	..	..	..	..	..	..	..	..	..	..	1(66)
									mad	..	..	..	..	..	1					
									cro	..	..	..	..	1						
									alt	..	..	..	..	1	..	..	1			
»	»	3⁰⁵ am	»	»	»	Y 200	2000	45	gl	..	..	6	5	4						
									Ben (Hyg)	(18)	(28)	(33)[44]	6							
									pun	..	..	1								
									Hum	..	1	..	1	1						
									mad	3	2	..	17	7						
									cro	1	..	..	..	1						
									alt	1	..	..	1							

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	7 ∨	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 ∧
207	28/8 10	8⁵⁰ pm	39°58′	3°41′	64	Y 200	25	15	mad	8	3									
»	»	9²⁰ pm	»	»	»	Y 200	65	15	mad	1	1									
208	29/8 10	1⁴⁰ am	40°18′	3°20′	>1600	Y 200	25	15	Ben	..	..	2	4							
									pun	..	..	..	..	1						
									Hol	1										
									Raf	3										
									mad	61	6	..	1	5						
209	29/8 10	4⁵⁵ am	40°34′	3°03′	>2000	Y 200	25	15	mad	9	3	1								
									cro	2										
»	»	5²⁵ am	»	»	»	Y 200	300	15	pun	..	1									
									Dof	..	1									
									mad	..	2	2								
»	»	6⁰⁰ am	»	»	»	Y 200	1000	45	gl	..	..	18	7	4						
									Ben	..	..	..	1							
									pun	..	..	..	..	1						
									Dof	..	..	..	..	1	..	..	1			
									mad	..	..	..	17	4						
									alt	..	..	..	..	..	..	3	2			
»	»	7²⁵ am	»	»	»	Y 200	2000	45	Ris	..	5									
									gl	..	..	21	1	3	1					
									Ben (Hyg)	(1)	(4)	(1)[20]	1							
									pun	..	..	..	1	1						
									Hum	..	1	1								
									Dof	1	..	1								
									mad	..	..	..	17	2						
									cro	..	..	..	..	1	1					
»	»	3⁴⁵ pm	»	»	»	Y 200	100	20	(Ben) (Hyg)	..	(10)									
									Hum	..	2	1								
									Dof	1										
									mad	7	2									
									cro	5										
									alt	3										
»	»	4²⁵ pm	»	»	»	C 200	150	20												
»	»	5¹⁰ pm	»	»	»	C 200	75—35	»	pun	..	1									
									alt	1										
»	»	5³⁵ pm	»	»	»	C 200	35—0	»												
210	30/8 10	2⁴⁵ am	41°10′	2°23′	780	Y 200	25	30	pun	..	..	..	..	..	1					
									mad	19	2									
»	»	3³⁵ am	»	»	»	Y 200	600	30	Ris	..	1									
									gl	..	..	1	1							
									(Ben) (Hyg)	(1)	(1)									
									pun	1	..	..	..	1						
									Hum	..	2									
									Dof	..	..	1	1	1						
									Hol	..	..	2								
									mad	2	..	9	5	6						
									cro	1	..	2								
									alt	..	..	..	..	..	..	..	1			
211	30/9 10	5²⁰ am	41°17′	2°13′	150	Y 200	25	60	mad	4										
213	31/8 10	3²⁵ am	40°14′	0°54′	75	Y 200	25	15	mad	19	5	2								
»	»	3⁵⁰ am	»	»	»	Y 200	95	15	(Ben) (Hyg)	(1)										
									mad	..	3	5								

St. No	Date	Hour	Position Lat. N	Position Long. E	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	V 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	Λ 50
215	31/8 10	9²⁰ pm	39°14′	0°52′	>1050	Y 200	25	30	pun	..	..	..	2							
									mad	122	57	3	56	7	..	..	..	1		
216	1/9 10	5¹⁰ am	38°31′	1°24′	> 85	Y 200	25	30	(Ben)											
									(Hyg)	..	(1)									
									mad	18	9	1								
217	1/9 10	1⁴⁰ pm	38°01′	1°48′	>2000	Y 200	300	15	Ris	2	2									
									gl	7	16									
									(Ben)											
									(Hyg)	(14)	(24)	(5)								
									pun	..	3	3	3							
									Hum	..	..	1								
									Dof	4	4									
									Hol	1	1	2								
									mad	3	4	2								
									elg	..	1	1	1							
									cro	6	2	1								
									alt	1	1									
218	2/9 10	2⁰⁰ am	36°54′	2°57′	ca2000	Y 200	25	30	gl	..	..	..	3	9	2					
									Ben											
									(Hyg)	(227)	(4)	..	..	..	..	..	..	..	1	
									pun	..	..	..	..	8	1	5	1			
									Dof	..	1	1								
									Hol	35	23	2								
									Raf	1										
									mad	18	4	..	58	..	..	..	..	3	9	
									elg	..	..	..	..	..	..	..	..	..	1	
									cro	74	11									
»	»	2⁴⁵ am	»	»	»	Y 200	300	30	Ris	..	4									
									gl	1	3	4								
									(Ben)											
									(Hyg)	(10)	(24)	(8)								
									pun	..	1	3	3	..	1					
									Hum	..	1	1								
									Dof	..	9	3	1	4	1	1				
									Hol	..	3	13	..	..	..	..	1			
									mad	..	..	3	4							
									elg	..	..	2	2	..	..	..	..	..	..	1 (52)
									cro	..	1	..	..	..	1	..	..	..	1	
									alt	2	..	1								
220	4/9 10	2¹⁵ am	36°25′	0°42′	> 350	Y 200	25	30	gl	..	..	3	2							
									(Ben)											
									(Hyg)	(18)	(13)	(1)								
									pun	..	..	..	..	6	3					
									Dof	..	..	80	59	6						
									Hol	10	61	17								
									mad	..	5	9	256	20	5	..	..	1	2	1 (50)
									elg	..	..	..	..	4	2	1				
									cro	3										
									alt	..	..	2	8	..	1	1	1			
				W																
221	4/9 10	6³⁵ pm	35°44′	0°53′	30	Y 200	25	15	(Ben)											
									(Hyg)	..	(1)									
									Dof	1										
									mad	3										
222	4/9 10	10⁵⁰ pm	35°53′	0°57′	ca2000	Y 200	25	15	(Ben)											
									(Hyg)	(1)										
									pun	..	..	..	1	5	2	1	..	1		
									Hol	19	56	36								
									mad	193	244	22	15	2	1	1				

St. No	Date	Hour	Position Lat. N	Position Long. W	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Mycotophum	7 V	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	50 Λ
222	4/9 10	11²⁰ pm	35°53′	0°57′	ca2000	Y 200	300	30	Ris	..	1	1								
									gl	4	23	9	4	..	1					
									(Ben)											
									(Hyg)	(7)	(44)	(4)								
									pun	..	..	3	1	..	..	..	1			
									Dof	2	10	5	2	2	2	3				
									Hol	..	3	3	..	..	..	..	1			
									mad	9	28	22	8	..	1	..	..	..	1	
									elg	1	7	4	1	1						
									cro	2	4	1								
									alt	..	1	..	1							
223	5/9 10	4³⁵ am	36°13′	1°28′	>2000	Y 200	25	15	Ben	..	..	..	..	..	..	..	..	..	1	
									Hol	..	5									
									mad	5	26	35								
									alt	..	..	..	..	..	..	2	1			
»	»	4⁵⁸ am	»	»	»	Y 200	300	30	Ris	1	2									
									gl	7	11									
									(Ben)											
									(Hyg)	(4)	(23)	(11)								
									pun	..	1	3								
									Dof	..	2	5	26	13	10	2				
									Hol	..	1	1	..	..	1	1				
									mad	..	1	9								
									elg	..	2	3								
									cro	..	1									
									alt	1	1	..	..	..	..	..	1			
»	»	5⁵⁰ am	»	»	»	Y 200	2000	30												
»	»	10³⁵ am	»	»	»	Y 200	2000	30												
224	5/9 10	7²⁰ pm	36°33′	2°00′	>950	Y 200	300	15	gl	5	5	32	50	9						
									(Ben)											
									(Hyg)	(18)	(45)	(6)								
									pun	..	1	1	1	3	1					
									Dof	..	1	15	5	1	1	2				
									Hol	..	3	1								
									mad	..	4	22	49	1						
									elg	..	3									
									cro		4	2	..	..	1					
									alt	7	1	..	6	..	..	5	1			
»	»	7⁵⁰ pm	»	»	»	Y 200	25	15	pun	..	..	..	..	3	1					
									Dof	..	..	2	1							
									Hol	2	6	1								
									mad	46	14	7	41	7						
									alt	..	..	..	..	..	..	..	1			
225	6/9 10	3³⁰ am	36°35′	3°00′	200	Y 200	25	15	(Ben)											
									(Hyg)	(89)	(7)	(1)								
									pun	..	..	..	..	4	4	1	1			
									Dof	..	3	2	..	1						
									Hol	25	66	15	1							
									mad	16	58	93	7	..	1					
									cro	69	28									
227	6/9 10	5³⁵ pm	36°33′	4°25′	99	Y 200	25	30	mad	73	12									
									cro	26	6									
228	7/9 10	0⁵⁰ am	36°02′	5°06′	>800	Y 200	1200	30	gl	..	4	37	10	4	..	3	..	..	1	
									(Ben)											
									(Hyg)	(1)	(2)	(1)								
									pun	..	2	1	1	1	..	..	..	..	..	1(52)
									Dof	..	..	3								
									Hol	1	..	6								
									mad	1	..	1	3							
									elg	..	1									
									cro	1	2	..	..	1	..	1				

St. No	Date	Hour	Position Lat. N	Position Long. W	Depth metres	Gear	Wire out metres	Duration of haul in minutes	Myctophum	∨ 7	7—10	10—15	15—20	20—25	25—30	30—35	35—40	40—45	45—50	∧ 50
228	7/9 10	1^{55} am	36°02′	5°06′	> 800	Y 200	300	30	gl	14	34	12	4	1	3	7	1	2	1	
									Ben	..	(6)	(8)	..	..	..	..	..	1		
									(Hyg) pun	..	3	2	1							
									Dof	..	..	1	..	..	3	5	1			
									mad	..	1	..	..	..	..	..	..	1		
									elg	..	1									
									cro	4	4	7	..	..	1					
»	»	2^{40} am	»	»	»	Y 200	25	30	gl	4	..	6	9	3	6	9	3	1		
									Ben	..	..	..	..	..	..	..	..	..	1	
									Dof	..	..	2	..	..	6	12				
									Hol	..	1	..	1							
									mad	5	3	..	2	..	..	..	..	1	9	2(50) +
									elg	..	..	..	..	1						1(51) +
									cro	2										1(55)
»	»	3^{45} am	»	»	»	D 1	1600	150	gl	..	..	..	..	..	..	..	..	1		

Stations of ^{S}/s „Pangan".

275	3/4 11	8^{30} pm	39°05′	E 14°50′	>1000	S 200	94	30	Hyg	..	..	..	3							
									Hum	..	..	..	..	..	..	..	1			
276	4/4 11	11^{20} pm	36°30′	19°20′	>3000	S 200	132	35	Hyg	..	..	..	4	1						
									Hum	..	..	..	..	..	1	1				
									Dof	..	..	5	1							
277	6/4 11	11^{20} pm	33°20′	27°30′	>3000	S 200	132	35	Hyg	..	..	..	9	6						
340	26/8 11	9^{00} pm	35°50′	21°30′	>2000	S 200	28	30	Coc	..	..	..	9	7	6	3				
384	7/11 11	8^{30} pm	32°50′	27°10′ W	>3000	S 150	130	30	Ben	..	..	1								
410	23/12 11	7^{00} pm	37°12′	1°18′ E	>1000	S 150	112	30	Ben	..	..	173								
743	23/9 13	10^{00} pm	34°26′	20°08′	c. 3000	S 200	95	30	Coc	..	..	..	..	..	..	1				

Specimens from the Straits of Messina,
collected on the shore by Capt. G. Hansen in March 1911.

Ris	..	..	..	..	..	..	1				
Ben	..	..	..	..	..	..	..	4	1	1	
Hyg	..	1	9								
pun	..	..	..	1	..	..	..	..	..	..	1(53) +
Hum	..	..	3	2							1(61)
Dof	..	..	1								
Hol	..	..	..	..	..	..	..	1	1		
mad	..	..	..	..	..	..	..	..	..	..	1(54)
elg	..	7	41	35	1						
cro	1	1	19	2	..	..	..	..	..	..	1(87)

III. APPENDIX.

1. Postlarvæ of Saurus griseus from the Atlantic.

From the West Indian waters we have some postlarvæ of *Saurus griseus*, Lowe (*Synodus saurus* L.), collected by the M/S "Dannebrog". They were taken at St. 776, $^{9}/_{3}$ 1914, 18°00′ N, 64°48′ W, with 180 m. w. and St. 777, $^{12}/_{3}$ 1914, 17°49′ N, 64°51′ W, with 180 m. w. There are 18 specimens in all, ranging from 5,5 to 24 mm ex. caudal. The pigmentation in these is as shown in Fig. 1, 1—2, but the postlarvæ appear, at the smaller lengths, to be farther developed in these waters than postlarvæ from the Mediterranean (cf. infra: postlarvæ of *Myctophum laternatum*).

We have also, from the same waters, three other forms of *Synodontid*-larvæ, extremely well distinguishable one from another by the different number of pigment spots, and different appearance and size of the same. One of these postlarvæ must be referred to *Synodus synodus* (L.) (cf. REGAN (1916) Fig. 4, Pl. VII).

2. Alteration in specific gravity of postlarvæ of the genus Myctophum during metamorphosis.

With further reference to what is stated on p. 17—21 as to the downward migration of the metamorphosis stages, and the relation of this migration to the presumable alteration in specific gravity of the postlarvæ, probably indicating a passive ontogenetic migration, I would here add that a determination, in sugar solution, of the specific gravity of large postlarvæ and of typical metamorphosis stages (taken with 300 and 2000 m. w. respectively) shows that the specific gravity of the metamorphosis stages is somewhat greater than that of the postlarvæ. The material has been preserved in a formol solution of abt. 4 % since 1910, and has for four or five months previous to the experiment been kept in an absolutely uniform solution. The preservation of the specimens for several years has probably altered their specific gravity somewhat, and it is therefore impossible to take the results of this small experiment as absolute proof that it is an alteration of the specific gravity and this alone which gives rise to the ontogenetic migration. I have noted them here, however, in order to call attention to the fact that such experiments with regard to specific gravity ought to be made in the actual course of the expedition. It may here be added that in a sugar-solution where the metamorphosis stages sank to the bottom, and large postlarval stages remained floating or suspended, specimens of *Girardinus* sp. of the same size sank to the bottom, after having been kept for 24 hours in a 4 % formol solution.

3. Postlarval stages of Myctophum laternatum, M. Valdiviæ and M. arcticum. — "Præscope"-larva of Holt and Byrne.

In the following, I give a brief mention, with illustrations, of the postlarval stages of two of the *Myctophum* species found in the Bay of Cadiz (*M. Valdiviæ* and *M. laternatum*) and which I have succeeded in identifying at the present stage in the treatment of the Atlantic material. I shall also shortly refer to one of the most northerly of the *Myctophum* species, *M. arcticum*. I hope subsequently to deal further with these species; a comparison between the Mediterranean and the Atlantic *Myctophum*-fauna will also, it is hoped, be given later on.

Furthermore, I have here to add a few words concerning certain of the Atlantic species, with the

particular intention of showing thereby, that in describing here the postlarvæ of *Myctophum arcticum*, the postlarval stages of the common species found north of abt. 45° N will have been described in this work. As far as I am aware, the only species belonging to the genus *Myctophum* mentioned in the literature as taken in the Atlantic north of 40° N are the following: *Myctophum arcticum, subasperum, glaciale, Benoiti, punctatum, Humboldti, phengodes, Coccoi, Andreæ* and *rarum; Diaphus Rafinesquei*; *Lampanyctus maderensis, elongatus* and *crocodilus*. Of these *Myctophum Benoiti, Coccoi, Andreæ* and *rarum* have not been taken north of 43° N. I shall, however, point out that a preliminary investigation of the material from the Atlantic shows that north of 45° N there are only few species; in the eastern Atlantic practically speaking only *Myctophum arcticum, glaciale, punctatum*; *Diaphus Dofleini* and *Rafinesquei*; *Lampanyctus elongatus* and *crocodilus*. In the waters between abt. 40° N and 45° N, there is a mixed area for northerly and southerly species; south of 40° N we encounter the numerous tropical and subtropical species.

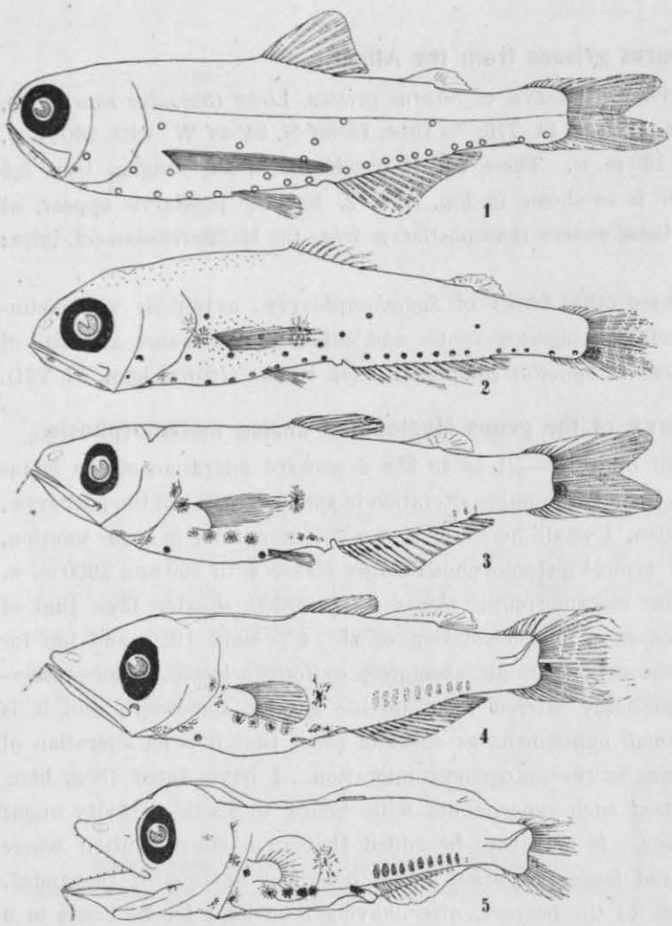

Fig. 46. *Myctophum laternatum*, Garman.
1: ♀, 20.3 mm ex. C.; S/S "Texas", Stat. 752, 20°00′ N, 21°55′ W, 220 m. w. out.
2: Metamorphosis stage, 13 mm ex. C.; "Thor", Stat. 91, 18/6 1910, 35°53′ N, 7°26′ W, 1600 m. w. out.
3: Postlarval stage, 11 mm ex. C.; "Thor", St. 89, 18/6 1910, 36°28′ N, 8°22′ W, 300 m. w. out.
4: Postlarval stage, 7 mm ex. C.; "Margrethe", St. 1017, 28°00′ N, 37°57′ W, 300 m. w. out.
5: Postlarval stage, abt. 5 mm ex. C.; "Margrethe", Stat. 1030, 35°31′ N, 55°58′ W, 600 m. w. out.

MYCTOPHUM LATERNATUM, Garman.

GARMAN (1899); BRAUER (1904 and 1906); ZUGMAYER (1911).

BRAUER believed that GARMAN's description and illustration represented this species; I must, however, point out that if GARMAN's figure is correct, then his Pacific species is not identical with this Atlantic form; there is too much difference between them in regard to the proportions, and position of the photophores. We should therefore bear in mind the possibility that this form may perhaps be an independent species.

The postlarval stages of the species are in the highest degree characteristic, and cannot be confused with the postlarvæ of any other known *Scopelid*; it will therefore here suffice to refer to the accompanying sketches, drawing attention also to the following: The postlarva has a barbel, which disappears as metamorphosis sets in; the eye of the postlarva is oblong (but without eye-taper); the pigmentation is markedly prominent, e. g. the large lateral melanophore.

Myctophum laternatum evidently occurs in the Atlantic in two forms, the postlarval stages from stations farther west in that sea being of shorter and heavier build than for instance stages at the same degree of development (with regard to formation of the fin rays, etc.) from the Bay of Cadiz; see Fig. 46, 4 and 5.

The species reaches maturity very early indeed, specimens of 17 mm excl. caudal having been found

with large eggs in the ovaries (cf. other *Myctophum* species). The antorbital photophore is smaller in the females than in the males (cf. BRAUER 1906 p. 178 and my statement with regard to certain *Diaphus* species p. 70 in the present work).

MYCTOPHUM VALDIVIÆ, Brauer.

BRAUER (1904 and 1906).

This is one of the most common species in certain parts of the Atlantic. I should here point out that there is evidently some difference between the Atlantic form and that from the Indian Ocean (e. g. the number of *AO* — cf. BRAUER (1906) p. 207).

The postlarva is extremely characteristic, and a closer description will not be necessary here, as there is no possibility of confusion with the postlarvæ of any other known species, if only from the fact that at a length of abt. 5 mm it is already as far developed as other *Scopelid* postlarvæ of twice or three times that length. Both adult and postlarval stages are evidently very delicate, being always more or less damaged from their stay in the nets.

The species attains maturity at a length of 15—20 mm (ex. C.). In respect of several characters, it occupies an isolated position among the *Myctophum* species. This applies not only to the position of the photophores, but also to the secondary sexual characters. Both male and female, for instance, have a supracaudal luminous plate (infracaudal organs not observed) but in the female the plate is of the simple elongated type, whereas in the male, it is markedly upturned at the rear, this being evidently the luminous portion (cf. for instance the corresponding organ in *Myctophum arcticum* and *M. glaciale*). The male has a larger eye than the female.

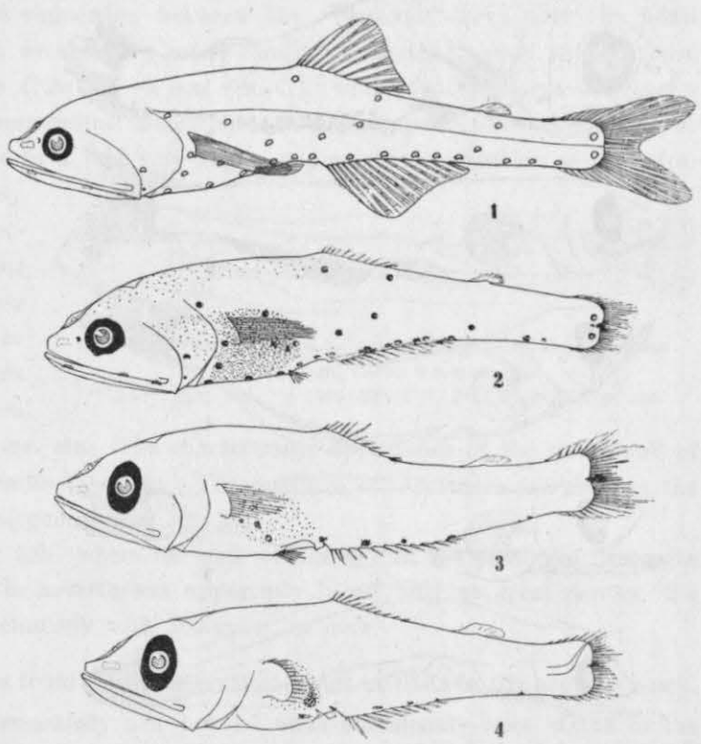

Fig. 47. *Myctophum Valdiviæ*, Brauer.
1: ♀, 15 mm ex. C.; "Margrethe", Stat. 1058, 29°24′ N, 48°08′ W, 65 m. w. out.
2: Metamorphosis stage, 8.5 mm ex. C.; "Margrethe", Stat. 1030, 35°31′ N, 55°58′ W, 1000 m. w. out.
3: Postlarval stage, 7.5 mm ex. C.; "Margrethe", Stat. 1030, 35°31′ N, 55°58′ W, 1000 m. w. out.
4: Postlarval stage, 4.7 mm ex. C.; "Margrethe", Stat. 1043, 31°59′ N, 59°52′ W, 110 m. w. out.

Though there may be certain characters (e. g. the elongated eye in the postlarva; certain features in the position of the photophores) by which the species is connected with the subgenus *Myctophum*, it is nevertheless doubtful whether we can properly refer it to that group; I am most inclined to establish a new subgenus for this species.

MYCTOPHUM ARCTICUM (Lütken).

Myctophum arcticum is represented in our material from the Atlantic by some adults and a number of postlarval stages from the collections of the "Thor" and the "Margrethe". I do not here propose to go further into the distribution of the species or its biological features, but it will doubtless be proper here

to note the few places in the literature where the species is mentioned. It was described and mentioned by LÜTKEN 1891 and 1892, as also in 1898 from Arctic areas (Greenland, Iceland). Since then, it has been described by HOLT and BYRNE (1911) from specimens taken in 1905 and 1907 off the coast of Ireland (two specimens; 15.5 and 24 mm ex. C.) the most southerly find here being 51°33′ N, 12°1′ W. It is also mentioned and described by BRAUER (1904 and 1906)[1]). GOODE and BEAN (1895) and JORDAN and EVERMANN (1896). Finally, as mentioned below, it is possibly this postlarva which is shown by HOLT and BYRNE (1913). The species has now been taken by the "Thor" right up in the Bay of Biscay, where the most southerly find was made (45°37′ N, 7°03′ W).

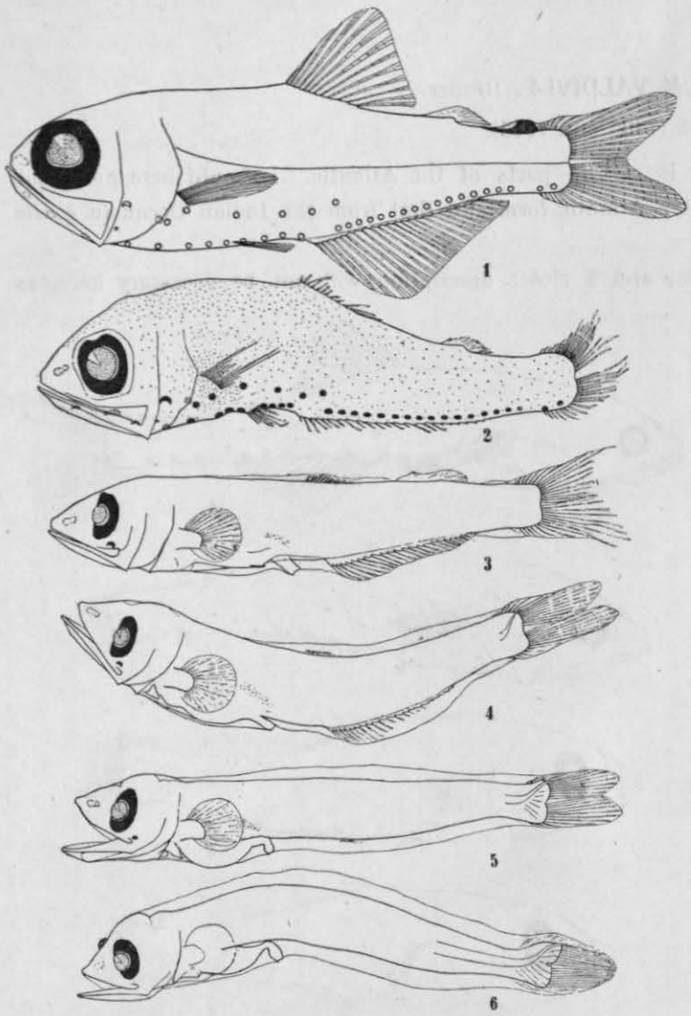

Fig. 48. *Myctophum arcticum* (Lütken).
1: ♂, 34.5 mm ex. C.; "Margrethe", Stat. 1002, 57°27′ N, 20°07′ W, 1000 m. w. out.
2: Metamorphosis stage, 15 mm ex. C.; "Thor", Stat. 180, 3/9 1906, 48°19′ N, 13°53′ W, 1800 m. w. out.
3: Postlarval stage, 14 mm ex. C.; "Thor", Stat. 90, 21/6 1905, 47°47′ N, 8°00′ W, 500 m. w. out.
4: Postlarval stage, 12.5 mm ex. C.; "Thor", Stat. 66, 6/6 1906, 48°43′ N, 15°17′ W, 400 m. w. out.
5: Postlarval stage, 10.3 mm ex. C.; "Thor", Stat. 66, 6/6 1906, 48°43′ N, 15°17′ W, 400 m. w. out.
6: Postlarval stage, 7.5 mm ex. C.; "Thor", Stat. 66, 6/6 1906, 48°43′ N, 15°17′ W, 400 m. w. out.

I have in the present work (p. 53) referred a postlarva shown by HOLT and BYRNE (1911, Fig. 1, Pl. I), to *Myctophum Hygomi*, and will therefore not omit to point out here that the mentioned postlarva should possibly be referred, not to *M. Hygomi*, but to this species (*M. arcticum*).

Closer description of the postlarva will not be necessary here; it will suffice to refer to the accompanying figures, calling attention also to the following points: The postlarvæ are unpigmented, save that there may be some slight internal pigment abdominally, and in older stages some few smaller melanophores in the abdominal region (cf. *M. Rissoi*). I have in some specimens seen a faint internal melanophore in the caudal region (ventrally to the urostyle). The eye is oblong (as in the *Myctophum* species, but the eye taper is lacking; this is, however, in *M. Rissoi*, only very slight, and is lacking in the two species above mentioned). *Brr* formed early; in the smaller stages, the intestine forms a curve, (cf. the "*Præscope*"-larva and *Myctophum* postlarvæ) and the anus lies a little in front of the fore margin of the anal fin (cf. *M. Rissoi*).

How far the postlarva of *Myctophum subasperum* (Günther) taken north of 40° N, resembles that of this species is not known; *M. subasperum* has, as far as I am aware, not been taken in the eastern parts of the North Atlantic.

HOLT and BYRNE (1913) mention p. 10 a postlarva which they compare with and regard as possibly

[1] See also under BRAUER's mention of the bipolar theory, cf. p. 352—356.

identical with the "*Præscope*"-larva described by them on p. 195—97 (Fig. 3) in the "Biscayan Plankton" (HOLT and BYRNE 1907) and which is referred to by FAGE (1910, p. 10, Fig. 7) from the Mediterranean. HOLT and BYRNE's Fig. 4, Pl. II (1913) of the only specimen of the postlarva taken off the coast of Ireland is, however, hardly identical with the "*Præscope*"-larva, but rather with the postlarva of *Myctophum arcticum* here shown. The "Thor" has in the deeper parts of the Mediterranean taken a number of specimens of the "*Præscope*"-larva, and there are also some from the Atlantic. It is the postlarva of *Argyropelecus hemigymnus*, Cocco, and the small sketch given below of the postlarva (Fig. 49) clearly shows the difference between the "*Præscope*"-larva and the postlarva of *Myctophum arcticum* (Fig. 48), which is hardly found in the Mediterranean.

The earliest stages of *Argyropelecus hemigymnus* have not previously been mentioned in the literature; there are, however, in the present material, series of postlarvæ which show that the "*Præscope*"-larva belongs to this species. A closer description of this will be published later on; for the present, I will merely note the structural features, etc. which establish the connection between the "*Præscope*"-larva and the adult *Argyropelecus hemigymnus* — a connection which we should *a priori* consider altogether out of the question.

The "*Præscope*"-larva is found in sizes from 4.5—9 mm (ex. C.); when the postlarva reaches a length of abt. 9 mm, we observe the slight, unpigmented indications of the group of photophores at the anal fin (see the semi-schematic Fig. 49) and also as a rule very slight, unpigmented indication of the infra-caudal group of photophores. Here, an extremely great reduction in the length of the postlarva begins (of up to $^1/_3$ rd or more) while at the same time the foremost part of the body is altogether transformed (the reduction seems particularly to affect the forepart of the body); the numerous photophores are developed, the eye is transformed to the telescopic type, the dorsal fin is formed, etc. etc. The characteristic appearance of the snout and of the intestine may be followed through a long series of stages. The numbers of myotomes are alike in the "*Præscope*"-larva and in small *Argyropelecus hemigymnus* (abt. 38—39).

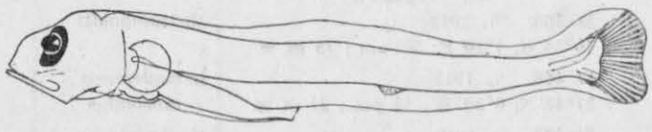

Fig. 49. "*Præscope*"-larva = postlarval stage of *Argyropelecus hemigymnus*, Cocco 9 mm ex. C. "Thor", Stat. 204, $^{27}/_8$ 1910, 38°52′ N, 7°43′ E, 300 m. w. out.

It is worth noting that in this telescopic fish, where the axis of the eye in the postlarva lies quite differently to that in the adults, the postlarva is nevertheless apparently found only at great depths, the "*Præscope*"-larva in our material being taken exclusively with 300 m. w. or over.

4. Brief survey of a smaller material of Scopelids from the Mediterranean, not utilised in the present work.

This material does not tell us anything essentially new beyond what has already been stated in the foregoing. It should be noted, however, that both in the Straits of Messina and elsewhere, the vessels found chiefly small postlarval stages.

Station, position, date, hour, m. w.	Species	<7	7—10	10—15	15—20	20—25	25—30
Straits of Messina.							
$^1/_3$—$^4/_4$ 1911. Night-hauls.	M. Rissoi	1					
Stramin-net, 100 cm in diam. at opening.	- Benoiti						
10—40 m. w.	- Hygomi	(5)	(3)	5			
Capt. G. HANSEN.	- punctatum...	3					
	D. Gemellarii ...	1	..	1			
	- Dofleini	9	1				
	L. maderensis ...	..	..	1			
	- elongatus	7	3	7	1		
	- crocodilus....	43[1]	4	1	1		
	- alatus	11[2]					

[1] Some of the smallest, 3—5 mm, perhaps belonging to *L. elongatus*.
[2] The smallest of these abt. 3 mm.

Station, position, date, hour, m. w.	Species	<7	7—10	10—15	15—20	20—25	25—30
S/S "Nordboen".							
St. 729. $^{14}/_{4}$ 1913. 41°00′ N, 17°44′ E; 11^{30} am.; 50 m. w.	L. crocodilus....	2					
St. 730. $^{16}/_{4}$ 1913. 38°26′ N. 13°37′ E; 2 pm.; 52 m. w.	L. crocodilus....	..	1				
St. 731. $^{19}/_{4}$ 1913. 37°19′ N, 1°31′ E; 2^{30} pm.; 50 m. w.	M. punctatum...	1					
	D. Dofleini.....	34					
	L. crocodilus....	3	3				
	- alatus	3					
St. 758. $^{11}/_{11}$ 1913. 37°32′ N, 0°36′ W; 10^{30} pm,; 220 m. w.	M. Benoiti	..	..	17			
	D. Dofleini.....	1					
	- Holti	..	4	2			
	L. maderensis...	8	3				
	- crocodilus....	3	6	1			
St. 759. $^{12}/_{11}$ 1913. 36°25′ N, 4°30′ W; 9^{25} pm.; 220 m. w.	M. Benoiti	..	..	1			
S/S "Algarve".							
St. 465. $^{23}/_{4}$ 1912. 40°56′ N, 1°10′ E; 2^{30} am.; 75 m. w.	M. Humboldti...	..	1				
St. 466. $^{4}/_{5}$ 1912. 37°45′ N, 0°30′ W; 11 pm.; 94 m. w.	L. maderensis...	2	1				
	- crocodilus....	1	2	1			
St. 467. $^{5}/_{5}$ 1912. 36°40′ N, 4°6′ W; 10^{30} pm.; 113 m. w	M. glaciale.....	11	..	..	..	..	1
	- punctatum...	4	..	..	1		
	D. Dofleini.....	..	..	3			
	L. maderensis...	24	6				
	- crocodilus....	18	4				
S/S "Pangan".							
St. 276. $^{4}/_{4}$ 1911. 36°30′ N, 19°20′ E; 11^{20} pm.; 132 m. w.	M. Humboldti...	1	1	1			
St. 298. $^{26}/_{6}$ 1911. 34°20′ N, 21°10′ E; 11^{30} pm.; 38 m. w.	L. maderensis...	31					
St. 339. $^{20}/_{8}$ 1911. 40°30′ N. 3°10′ E; 3 am.; 28 m. w.	L. maderensis...	7					
St. 340. $^{26}/_{8}$ 1911. 35°50′ N, 21°30′ E; 9 pm.; 108 m. w.	L. maderensis...	1					
St. 412. $^{7}/_{1}$ 1912. 34°33′ N, 24°15′ E; 6^{30} pm.; 112 m. w.	M. Benoiti or Hyg.	(6)					
St. 531. $^{9}/_{8}$ 1912. 37°17′ N, 4°03′ W; 8^{30} pm.; 57 m. w.	M. punctatum...	..	..	..	..	2	
	L. crocodilus....	2					
St. 698. $^{25}/_{2}$ 1913. 37°20′ N, 9°25′ E; 5 am.; 95 m. w.	L. crocodilus....	8	3	1			
St. 699. $^{27}/_{2}$ 1913. 36°00′ N, 18°58′ E; 5 am.; 95 m. w.	M. Benoiti or Hyg.	(2)					
	L. alatus	6					
St. 718. $^{17}/_{5}$ 1913. 36°13′ N, 13°53′ E; 8^{15} pm.; 60 m. w.	M. Hygomi.....	..	..	..	1		